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The Opilionid Subfamily Ortholasmatinae (Opiliones, Troguloidea, Nemastomatidae)

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ABSTRACT

Three new opilionid species from North America are described: *Ortholasma levipes, O. setulipes,* and *Dendrolasma dentipalpe.* The genera *Trilasma* and *Ruaxphilos* are synonymized with *Ortholasma*; the synonymy of *Cladolasma* with *Dendrolasma* is confirmed. The new subfamily Ortholasmatinae is established for *Ortholasma* and *Dendrolasma,* under the family Nemastomatidae; previously these genera had been considered members of the Trogulidae. Extensive descriptions and illustrations are provided of the morphology of members of the subfamily, together with information on postembryonic development, biogeography, and ecology. A cladistic analysis of the known species is presented.

INTRODUCTION

The order Opiliones contains many animals of an unusual, even fantastic appearance. Heavily ornamented with bizarre spines and tubercles and often having grotesque proportions, most of these peculiar forms are found in the tropics and belong to the suborder Laniatores. It is all the more remarkable then to find a group of small nemastomatids ranging from the Mexican highlands nearly to Alaska whose body form and cuticular sculpture in every way resemble their distant tropical cousins' armature. When ortholasmatines are examined under the microscope, one sees an eye tubercle evidently extended into a voluminous hood which conceals the palpi and chelicerae from above. In addition, the sculpture of the body is so unusual, having the appearance of a continuous cuticular lattice suspended above the body surface, that there seems to be nothing like it in the animal world. Any thinking biologist must wonder how such a structure could ever come into being through the normal process of arthropod molting.

Members of this remarkable group of opilionids first came to light when Nathan Banks described *Ortholasma rugosum* in 1894. At that time, family limits in the Opiliones were poorly understood; because of the extended eye tubercle and the flattened body form, Banks placed his new genus in the family Trogulidae. This mistaken arrangement was followed for nearly 80 years (Bragg and Leech, 1972), though specialists who had examined species of *Ortholasma, Dendrolasma, Cladolasma,* and *Trilasma* had raised questions about it, speculating that the genera really belonged in Nemastomatidae. That has proven to be the case, and we describe below the new subfamily Ortholasmatinae to accommodate what we think are the two genera that should be recognized, *Ortholasma* and *Dendrolasma.*

Work on this study began nearly 15 years ago when Jürgen Gruber examined North American representatives of the Ortholasmatinae for the purpose of making comparisons with European trogulids. However, the work was not put into final form until the present because of pressing duties and other projects.

The accumulation of many new specimens from the United States and the description of new species from Japan (Suzuki, 1963) and Mexico (Šilhavý, 1973) mobilized our desire to collaborate on a comprehensive revision of these interesting animals. Accordingly, Gruber wrote most of the text and made the drawings, and Shear checked new records, examined recent collections, took scanning electron micrographs, edited the text, and saw it through the press.

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Abbreviations

AMNH, American Museum of Natural History, New York, NY
BMM, Thomas Burke Memorial Museum, University of Washington, Seattle, WA
FMNH, Field Museum of Natural History, Chicago, IL
MCZ, Museum of Comparative Zoology, Harvard University, Cambridge, MA
NMS, Natur-Museum und Forschungs-Institut Senckenberg, Frankfurt, Germany
PMBC, Provincial Museum of British Columbia, Victoria, BC, Canada
USNM, National Museum of Natural History, Smithsonian Institution (arachnid collection on loan to AMNH)
WAS, personal collection, William A. Shear, Hampden-Sydney, VA

ADULT MORPHOLOGY

The following concise description of adult morphology is given as an aid to comparison with other groups and to shorten the species descriptions through references to general traits.

General Appearance and Proportions: The body is dorsally flattened; the scute is only slightly convex. On the frontal border of the carapace, the eye mound carries a club-shaped median process inserting dorsally to rostrally, which rises slanting forward or is nearly horizontal. From this process extend enlarged anvil-shaped tubercles on either side, with their crossbars overlapping so that the characteristic fenestrated appearance is produced. This complex structure forms the dorsal wall of the hood which, in adults, covers the chelicerae and palpi. The lateral walls of the hood are formed by one or two large conical processes of the carapace on either side (figs. 3–14).

The dorsal surface is covered by an elaborate pattern of cuticular sculpture which superficially seems to consist of a lattice of rectangular to hexagonal cells defined by a network of cuticular bars suspended above the surface on posts, but in reality this lattice is produced by the close appression of the lateral arms of enlarged anvil-shaped tubercles to one another (figs. 15, 16). The bases of these tubercles form the posts which appear to support the lattice. In some species, tubercles on either side of the midline are prolonged above the lateral arms to show up as blunt spines. At the caudal borders of the scute and the free abdominal tergites, this unusual sculpture has the appearance of a post-and-rail fence (figs. 16, 167).

Pleural sclerites may be visible in the membranes on the sides of the abdomen. The free tergites of the abdomen are usually not visible from above, but form part of the ventral side. In well-fed animals they may be nearly vertical. The venter is more convex than the dorsum.

The extremities are comparatively short; the chelicerae and pedipalps are both only about half the length of the body. The legs in order of length are 2:4:3:1, with the following ranges in femoral length in mm. in that order: 2–3.5 (5.4) : 1.5–2.5 (3.2) : 1.1–1.5 (2.3) : 1–1.5 (1.9). In each case, the value given in parentheses is for the troglobite *Ortholasma sbordonii,* which has longer legs due to its peculiar adaptations.

The coloration is drab, mostly dark brown, rarely with a pattern of lighter pigment. There are never silver or golden spots and flecks as in other nemastomatids, and freshly collected specimens usually have a coating of dirt, which appears to be held on by the cuticular sculpture and possibly with the aid of a glutinous secretion from subcuticular glands.

In summary, ortholasmatines have a "trogulid-like" facies, with their depressed bodies, hoods hiding the anterior appendages, and their coat of soil, and this was the reason for their original placement in the Trogulidae. However, we now recognize that the adaptations leading to trogulid-like appearance are found in unrelated lines, and animals that look superficially like trogulids are known

in the families Nemastomatidae, Ischyropsalididae, and Dicranolasmatidae as well. Likewise, the "*Ischyropsalis*-like" *Nipponopsalis* has been shown to be very close to the real trogulids (Martens and Suzuki, 1966; Martens, 1976; Martens, Hoheisel, and Götze, 1981).

CUTICULAR SCULPTURE: The elements of cuticular sculpture are as follows: a) relief of the body is poorly developed except for the obvious median boss of area 2 and the median process of the eye mound; b) macrosculpture ranges from 0.01 to 0.1 mm. in size and includes anvil-shaped teeth, warts, tubercles, and spines as described below; c) microsculpture ranges from 0.01 mm. downward and includes denticles, granulations, and microtrichia; d) the smallest elements are about 0.005 mm. or less in size and are minute granulations and denticles interspersed among the larger elements; e) setae or hair sensillae include the short setae of the body, longer hairs of the extremities, clavate hairs of the pedipalps, hairs of the epigamic glands, tactile setae, and others.

As an example of the sculpture of the body region, we may take *Dendrolasma mirabile.* Typical anvil-shaped teeth form the border rows of the coxae and the keels of the dorsal scute (fig. 162). They have only a slightly granulated base and a head covered with large microdenticles which often subtend small setae; the head generally has but two arms. The anvil-shaped teeth are connected to one another by their closely appressed arms, which are flattened against one another (fig. 162). At the branching points of the keel lattice are found star-shaped teeth with three, four, or even five arms (fig. 15). On either side of the scute midline occur major teeth which are elongated into spines beyond the level of the keel lattice; likewise on the caudal borders of the scute and free tergites, typical two-armed teeth are very much elongated, and with their closely joined arms present a fencelike appearance (fig. 16). The lateral processes at the anterior margin of the carapace (fig. 165) are simply exaggerations of this kind of tooth; the base has become greatly enlarged, the arms are reduced, and the spine much extended. In contrast, the lateral teeth springing from the median eye mound process (figs. 17, 166) have their arms exaggerated; in Mexican species of *Ortholasma,* the dorsal surface of the median process has a row of free-standing star-shaped teeth that are only sporadically joined to the lateral teeth, or to each other (figs. 12, 13).

The sternites, genital operculum, coxal surfaces, and leg trochanters show simpler, wart-shaped tubercles (fig. 164), their surfaces covered with microdenticles and setae resembling those found on the anvil-shaped teeth, but at their borders and in the regions of apodemes, these tubercles show transitional forms with the anvil-shaped teeth. Between the tubercles the cuticle is finely granulate with occasional tiny setae.

The sculpture of the legs (figs. 18, 47, 64, 104, etc.) is strongest on the femora and becomes less distinct on the distal segments; it consists of microdenticles variously grouped and arranged, and of microtrichia, especially on the distal segments. Because this sculpture is of great taxonomic value, it is described and illustrated in detail for each species.

Long, ordinary setae are found on the pedipalps ventrally on the trochanters and the bases of the femora, where they originate from low warts. Short, frequently blunt setae occur dorsally and apically on the trochanters, femora, and patellae. The highly specialized clavate hairs appear ventromedially on the femora and patellae and on all surfaces of the tibiae and tarsi, but there is a strong tendency in *Dendrolasma* for these hairs to be replaced by ordinary setae at the adult molt (see section below on development).

SEXUAL DIMORPHISM: The differences in proportions between the sexes are detailed in the species accounts, but generally speaking males are smaller, have more flattened bodies, and longer legs in proportion to their bodies. Tarsal segment counts on legs 1 and 2 are higher in males. The male genital operculum is smoothly continuous with the following sternite and is tongue-shaped; in the female there is a suture between the operculum and the sternite and the operculum itself is broadly rounded, with an apical shining lip, which bears a transverse oval concavity.

The basal cheliceral article of the males (figs. 33, 34, etc.) may or may not bear a dorsal cuticular tooth, and in *Ortholasma, sensu stricto* there is an epigamic gland with

a hairfield dorsoapically. The distal article always has a large, median cuticular tooth in males. Epigamic glands are also present in the pedipalpi of the males, occurring on the femora, patellae, and tibiae in various patterns as described in the species accounts. In *Dendrolasma mirabile,* the males have strongly enlarged patellae with flattened medial faces. *Dendrolasma dentipalpe* males bear a small black tooth distomedially on the palpal patella; the females of this species are unknown.

GENITAL MORPHOLOGY: MALE: Vagina penis with two dorsolateral narrow longitudinal bands of sclerotized cuticle, otherwise membranous, folded. The penis (figs. 75–90, 182–185, etc.) is long and narrow, generally 30–40 times as long as wide. The base, about one-seventh of the shaft length, is bulbous and contains two stout muscles with long tendons extending up the shaft to insert on the base of the glans. The glans is dark brown, evenly tapered in line with the margins of the shaft and continuing without a break into a long stylus. The glans is sclerotized ventrally but is pale and membranous dorsally; the setation may be monomorphic or dimorphic, as described under the species accounts. The stylus is more or less curved at its apex, and in *Ortholasma* it is bent into a hook, whereas in *Dendrolasma,* helical torsion occurs.

FEMALE: The ovipositor (fig. 187) is of the nemastomatid type. The corpus consists of soft, folded cuticle with sparse setation becoming more dense distally and springing from slightly protruding, rounded sclerites. The apical furca has two divisions, the basal with four oval and the distal with two crescentic sclerites bearing long setae. The opening is slitlike. The seminal receptacles are simple, rounded sacs sometimes with a smaller, distal invagination.

JUVENILE STAGES AND POSTEMBRYONIC DEVELOPMENT

Because only a few specimens of young ortholasmatines are available, the following material applies primarily to the larger stages, presubadults and subadults. A good description of the former stage of *Dendrolasma parvulum* has been published by Suzuki (1963).

The body form of subadults resembles that of fully grown specimens, with a depressed and flattened dorsum, but the softer body wall allows a more rounded form, depending on the nutritional state. Smaller nymphs have the oval body of typical nemastomatids. The individual sclerites of the dorsum are clearly visible even in the larger stages, and are often brown against the lighter surrounding membrane.

The dorsum in subadults invariably shows a free metapeltidium bounded by membranous folds, as in many other nemastomatids. The scute is not yet fully sclerotized; the union of the individual sclerites begins in the midline so that the lateral margins of the subadult scute are deeply indented. Body integument is generally paler and the complex sculpture of the adults is completely lacking; this is characteristic of other nemastomatid genera with elaborate adult sculpture. Instead, the macrosculpture is represented by low conical tubercles, which, according to their position, are the precursors of the enlarged tubercles, knobs, and spines of the adults.

As in other trogulid-like forms (*Dicranolasma*), the lack of a hood represents a major developmental break between nymphs and adults. Subadults have a relatively small median process without fenestrations, and the palpi and chelicerae are not covered by it. The smallest known nymphs show a conical tubercle on the eye mound. In subsequent stages, this tubercle elongates and becomes club-shaped finally showing on either side a series of warts that will become, with the adult molt, the lateral anvil-shaped teeth. The median process precursor has a forward slant but, in all species except *Dendrolasma dentipalpe,* is never as depressed as in adults.

In subadult males, the cheliceral glands may be represented by low but discernible swellings; the characteristic cuticular teeth are entirely lacking.

The palpi of the nymphs are relatively longer compared to body length than in the adults. Up to the subadult instar the development of the palpi appears to be linear, but with the adult molt there is a substantial change in relative dimensions as the palpi remain about the same size and the body becomes larger. This negative allometry is in part responsible for the ability to retract the palpi completely under the newly developed

TABLE 1
Characters for Cladistic Analysis of Families

CHARACTERS	PLESIOMORPHIC	APOMORPHIC
1. Penis	With three muscles	With two muscles
2. Ovipositor type	Segmented	Troguloid type
3. Prosomal sternum	Free	Fused to leg coxae
4. Palpal setation	Plumose setae	Clavate setae
5. Palpal claw	Well developed	Reduced
6. Glans penis	No lateral flaps	With lateral flaps
7. Chelicerae	Normal	Elongated
8. Female abdomen	All tergites free[a]	Scutum parvum or magnum
9. Abdominal sternites	Free, not divided	Divided in midline, fused into ventral scutum
10. Scutum	Parvum	Magnum
11. Troguloid facies	Absent	Paired hood, basal eyes
12. Cuticle	Without glandular papillae	With glandular papillae
13. Palpi	Long, with clavate setae	Short, clavate setae reduced in number
14. Corpus of ovipositor	Setae not on papillae	Setae on papillae
15. Penis sheath	Stiffening rods present	Stiffening rods absent
16. Penis muscles	Long, with short tendons	Short, with long tendons
17. Cuticular sculpture	Not thorny, not obviously glandular	Glandular and thorny
18. Calcaneus of metatarsi	Present	Reduced[b]
19. Troguloid facies	Absent	Paired hood carrying eyes midway
20. Clavate setae of palpus	Retained in adults	Reduced in adults
21. Scutum	Parvum	Magnum
22. Penis muscles	Extending half way up shaft	In bulb at base of shaft
23. Scutum	Parvum	Magnum
24. Troguloid facies	Absent	With unpaired hood, dorsal on eye tubercle

[a] All species not examined.
[b] Martens (1978) implies the opposite polarity.

hood. In addition, the young stages have the palpi densely covered with clavate hairs of the kind described by Wachmann (1970) for nemastomatines. In adults, some or most of these hairs are succeeded by ordinary setae. Those on the distodorsal side of the tibia seem to show the greatest resistance to being so replaced. We did not have the material available to be able to describe the course of development of the sexually dimorphic features of the palpi.

The legs of subadults and earlier instars are proportionally shorter, the tarsal joints are fewer in number, and pseudoarticulations are lacking (except on the metatarsi).

Identification of nymphs to species is problematical, but at least in the later stages some of the characteristic microsculpture of the legs may be developed, and in *Ortholasma pictipes,* the diagnostic light middorsal stripe develops early.

In summary, the most remarkable fact about ortholasmatine development is the metamorphosis-like change that takes place with the adult molt. The hood and elaborate macrosculpture appear and the proportions of the body change strikingly.

EVOLUTION AND RELATIONSHIPS

In attempting to organize characters into transformation series from plesiomorphic to

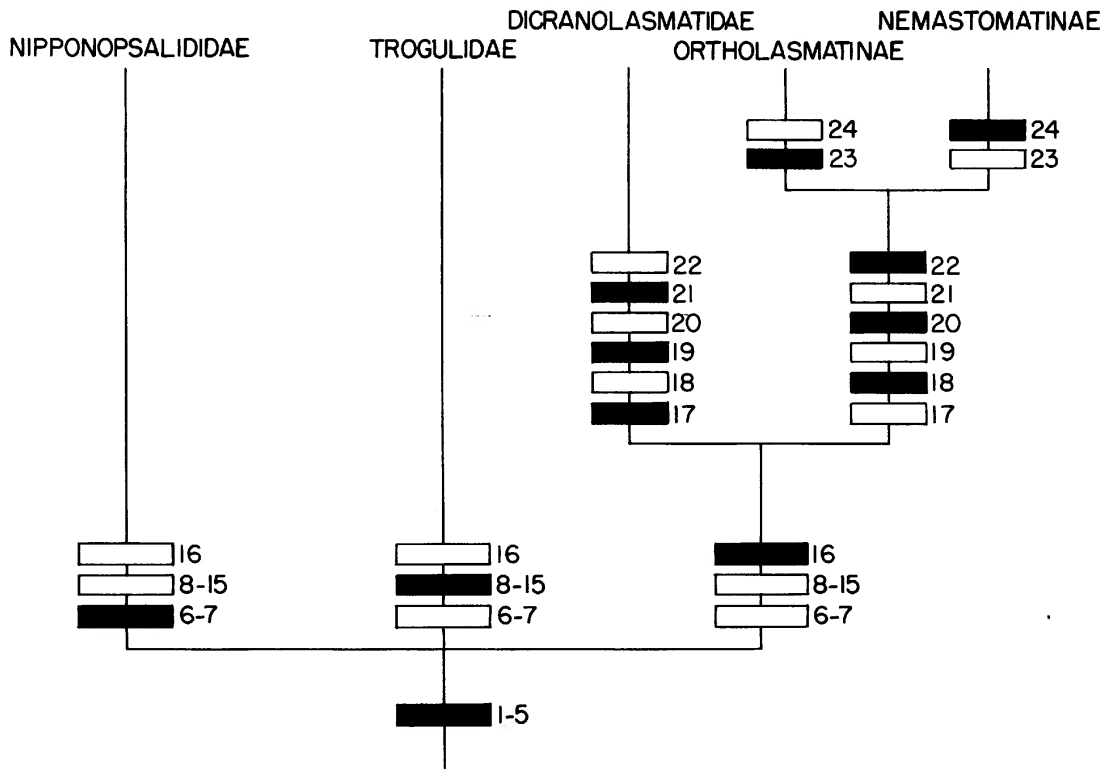


FIG. 1. Cladogram of Nemastomatidae and related families. See text for explanation.

apomorphic, we have been guided by the following "rules of thumb": (1) occurrence in outgroups speaks for plesiomorphy, 2) less differentiated, more homonomously patterned meristic characters are plesiomorphic, 3) states resembling those in juveniles are plesiomorphic, 4) characters consistently correlated with others known to be apomorphic are likely themselves to be apomorphic, and (5) correlations between morphological and chorological or ecological positions (as in the foregoing) are to be used with caution.

SCUTE SEGMENTATION (characters 10, 21, and 23, table 1; 17, table 2): A free metapeltidium and scutum parvum occur in all *Ortholasma* species and in *Dendrolasma parvulum*; the other two *Dendrolasma* species show an obliteration of the divisions and a transition to scutum magnum. The primitivity of the former is demonstrated by (1) widespread occurrence in outgroups and in a predominant number of palpatorid families, by (2) the presence of scutum parvum in nymphs of all species, and by (3) correlation in the two *Dendrolasma* species of "near scutum magnum" with other derived characters, such as palpus shape.

SCUTE ORNAMENTATION (characters 5 and 18, table 2): Three basic patterns exist. In the subgenus *Trilasma* and in *Dendrolasma parvulum*, a mixed type occurs with both large and small keel cells, in *Ortholasma, sensu stricto* and *D. mirabilis* a simpler pattern with only large cells occurs, and in *D. dentipalpe* there are only small cells. This case is difficult to deal with because this type of ornamentation is not found in any outgroup, and does not appear in the ortholasmatines until the final molt. However, by using rules (4) and (5) we hypothesize that the mixed pattern is primitive and each of the others is independently derived from it.

HOOD (characters 1, 4, 6, and 16, table 2): In *Trilasma* the hood is large, highly arched, and the median process inserts nearly dor-

sally on the eye mount; it also bears anvil-shaped and star-shaped teeth dorsally. In *Ortholasma, sensu stricto* through *Dendrolasma,* the hood becomes more depressed and less complex. The median process comes to be inserted rostrally, the hood extends horizontally and the lateral processes of the carapace are reduced from two to one. Dorsal anvil-shaped teeth are absent and the supraocular keels are likewise reduced. This trend is strongly correlated with shortened palpi in which the numbers of clavate hairs are drastically reduced. Further, as shown above (in the section on development), the juveniles have more highly arched hood rudiments, longer palpi, and more numerous clavate hairs in every species examined. Thus, according to rules (2); (3); and (4), we hold the highly arched hoods, dorsal teeth on the median process, well-developed supraocular keels, two lateral processes on each side, and higher counts of clavate hairs on longer palpi to be primitive.

GENITAL MORPHOLOGY (characters 1, 15, 16, and 22, table 1; 2 and 14, table 2): By outgroup comparison (1) and in some cases by patterning (2), we find the following to be apomorphic: penial muscles short, with long tendons, sometimes in a bulb at the base, dimorphic penial setation and having the stylus terminate in a hook. In the first character, which occurs in the entire family Nemastomatidae, comparison was made with the Trogulidae, in which the penial muscles are long and occupy most of the shaft. Monomorphic penial setation is the rule in the ortholasmatines and the nemastomatines. A broader outgroup comparison with nearly all palpatorids suggests that penial asymmetry is apomorphic whenever it occurs, but has developed independently in most families.

SECONDARY SEXUAL CHARACTERS OF MALES (characters 3, 9, and 19, table 2): The presence of epigamic glands is more specialized than primitive for opilionids as a whole, but their subsequent loss may be a further apomorphic development. As an example, epigamic glands are found on the male chelicerae in nearly all nemastomatid species, dicranolasmatids, and ischyropsalidids. Parallel development is not impossible, but we think that outgroup comparison leads to the hypothesis that the presence of the cheliceral gland is plesiomorphic for ortholasmatines (found only *Ortholasma, sensu stricto*). On the other hand, epigamic glands in the palpus rarely occur among opilionids and are probably apomorphic, but because of what appears to be parallelism and secondary loss, we are not confident in making this suggestion. As one of us has stated (Shear, 1980), the occurrence of some kind of epigamic gland is to be expected in opilionid groups, but the position of such glands is highly variable even within families.

MERISTIC CHARACTERS: Lengthened legs are apomorphic for Opiliones in general; this trend continues within groups. Correlated with longer legs are increases in tarsomere counts and the occurrence of pseudoarticulations in progressively more proximal leg segments. By outgroup comparison with *Dicranolasma,* the absence of a metatarsal calcaneus is apomorphic.

FEMORAL MICROSCULPTURE (character 10, table 2): Applying rule (2) suggests that those species having a uniform distribution of denticles on the leg femora are in a more primitive condition for that character than those that have them grouped, giving the legs a "bumpy" appearance. Likewise, rule (1) suggests that the setiform microsculpture of *setulipes* is apomorphic.

COLOR PATTERN: According to rules (1) and (2), the median light stripe of *Ortholasma pictipes* is an apomorphy.

The Ortholasmatinae seems to be a natural, monophyletic group united by many apomorphies, but the relationships of the group to other opilionids has been unclear and the subject of a good deal of speculation. Certainly, the group does not belong to Trogulidae, as originally suggested by Banks, who was followed for many years. Suzuki (1974) was probably the last taxonomist to take this position by placing *Dendrolasma* in the Dicranolasmatinae as a subfamily of the Trogulidae. However, current opinion holds that the Dicranolasmatidae is a separate family closer to the Nemastomatidae than to the Trogulidae, and we are sure that the Ortholasmatinae (hence *Dendrolasma*) obviously belongs in the Nemastomatidae. The similarities between the dicranolasmatids and the ortholasmatids are superficial. The hoods have entirely different forms and origins, the

body sculpture is quite different, and calcanei are lacking from the leg metatarsi in the ortholasmatines. *Dicranolasma* has specializations of its own, notably the thorny cuticular sculpture and the elongated fourth metatarsus. So, based on the genital morphology, form and setation of the palpus, and the cuticular sculpture, the sister group of the ortholasmatines is the subfamily Nemastomatinae, an entirely Palaearctic group, whereas the sister group of nemastomatids as a whole is the Dicranolasmatidae.

The west Palearctic nemastomatids are best retained in a single subfamily Nemastomatinae (see the views of Gruber, 1976, versus those of Kratochvíl, 1958). They differ from the American forms in having scutum magnum in all adults, and a more normal body form (not showing the troguloid facies; but see Gruber's 1976 description of *Mediostoma ceratocephalum*). Otherwise there is a good deal of variability in genital morphology, and the subfamily Nemastomatinae is much richer than the Ortholasmatinae in genera and species.

To digress briefly, we might note that the general facies or appearance of an opilionid group can be misleading. The case at hand is the best studied and at the same time the most obvious, but Martens (1976) was able to show that *Nipponopsalis,* a genus found in Japan and Korea and strongly resembling the European *Ischyropsalis* and the American *Taracus* (Martens and Suzuki, 1966), was not at all related to them, but instead was a member of a new family close to the trogulids. Further unpublished studies by Shear suggest that despite the superficial similarities (enlarged chelicerae, removed eye mound), *Taracus* itself is close to *Sabacon* not *Ischyropsalis.* Gruber (1978) demonstrated that the trogulid-like *Ceratolasma tricantha* of Oregon did not belong to the Trogulidae where it was described, nor to the superficially similar ortholasmatines, but to the Ischyropsalididae. Indeed, it seems to be the closest relative of *Ischyropsalis.* An undescribed genus in this same group of ischyropsalidids is the strangest yet, looking like a tropical cosmetid!

Suspected polarity judgments on characters and groups are likewise being reversed. Among the Laniatores, the Oncopodidae traditionally had been thought to be primitive, yet many factors now point to its being among the most specialized families of its suborder (Martens, Hoheisel, and Götze, 1981). The suborder Cyphophthalmi has been shown to have many advanced specializations (Shear, 1980) and to be related to the suborder Palpatores, so that Martens, Hoheisel, and Götze (1981) suggest a new group, "Cyphopalpatores," as the sister group of the Laniatores.

Returning to the point at hand, while the Ortholasmatinae and Nemastomatinae should, in our opinion, be united in the same family (Nemastomatidae), the two subfamilies have been separated and have gone their separate evolutionary ways for a long time.

We have tried to summarize the above discussion and suggest relationships of the ortholasmatines to other groups in tables 1 and 2 and figures 1 and 2, cladistic analyses. Figure 1 covers the families of the superfamily Troguloidea, whereas figure 2 deals with the genera and species of ortholasmatines. According to Martens, Hoheisel, and Götze (1981) the sister group of this superfamily consists of all the other "Cyphopalpatores." The construction of the cladogram includes trichotomy. We know of numerous autapomorphies for each of the four families involved, but have been unable to find good synapomorphies that would conclusively demonstrate the Nipponopsalididae to be the sister group of all the other families taken together, as we suspect is the case. We admit to a strong intuition that our hypothesis of this relationship will be supported by characters not yet studied. We would suggest searching for these characters in the chemistry of exocrine gland secretions, and in the very fine details of structure revealed by the SEM.

BIOGEOGRAPHY

Since our knowledge of the ortholasmatines is probably far from complete, this subject should be approached with caution. As we show, at least one additional species each may be expected from California and Mexico, and additional discoveries are possible in British Columbia and Alaska. Ljovushkin (1971) found a species of *Taracus,* a typical Rocky Mountain genus, on the east Asian mainland, and since *Dendrolasma* is already known from Japan, it would not surprise us

TABLE 2
Characters for Cladistic Analysis of Species of Ortholasmatinae

CHARACTER	PLESIOMORPHIC	APOMORPHIC
1. Lateral hood processes	Two	One
2. Stylus of penis	Straight	Hooked
3. Cheliceral gland	Present	Absent
4. Dorsal tubercles on median hood process	Present	Absent
5. Scute ornamentation	Mixed	Large cells
6. Hood insertion	Dorsal	Rostral
7. Femoral and tibial pseudoarticulations	Absent	Present
8. Femoral microsculpture	Evenly scattered	Clustered, "bumpy"
9. Glands in male palpi	Absent or diffuse	Present, large
10. Femoral microsculpture	Denticulate	Nearly setiform
11. Femoral pseudoarticulations	Few	More
12. Color pattern	Uniform	Median light stripe
13. Cheliceral gland setae	Dense on small area	Scattered on larger area
14. Penis setation	Monomorphic	Dimorphic
15. Troglobitic adaptations	Absent	Present
16. Hood shape	Large, nearly circular in outline	Smaller, narrow
17. Scutum	Parvum	Magnum
18. Scute ornamentation	Mixed	Large or small cells (alternative derivatives)
19. Male palpal patella	No tooth	Tooth present

to have an ortholasmatine turn up from continental northeastern Asia.

DESCRIPTIVE BIOGEOGRAPHY: The extent of species ranges varies widely in the subfamily. *Ortholasma sbordonii* (map 3) and *Dendrolasma dentipalpe* (map 2) have small, restricted ranges, while *O. pictipes* and *D. mirabile* have extended ranges along the northwest Pacific Coast of North America (map 2). *Ortholasma pictipes* shows allopatry with the other Californian *Ortholasma* species, whereas *O. levipes* evidently occurs with *O. rugosum* in the northern part of its range, and with *O. setulipes* in the southern part (map 1). The separation of the range of *levipes* into Coast Range and Sierra Nevada foothill sections is likewise interesting, but incomplete records may be responsible for this apparent disjunction; nonetheless other soil-dwelling invertebrates show such a pattern and sometimes vicariant species occur in this way. *Dendrolasma mirabile* and *D. dentipalpe* are, as far as we know, allopatric.

Because so little is known of the ecological preferences of any of the species (see the notes under species descriptions), syntopy is difficult to postulate, even when series of specimens from the same collection are made up of more than one species, like the "type series" of Banks for *rugosum,* which also contained specimens of *levipes.* It seems to us that an autecological study of the several California species would be of great interest.

Descriptive biogeographers of California would recognize the American species of *Dendrolasma* and *Ortholasma pictipes* as "Vancouveran" in the sense of Van Dyke (1919) or "Oregonian" (Munz and Keck, 1959), or as belonging to the Pacific Border Province of Savage (1960), or to the Northern Pacific Coast Rainy Western Hemlock Forest Biome of Shelford (1963), and so on.

Ortholasma levipes and *O. setulipes,* on the other hand, are "Californian" (Van Dyke, 1919; Linsley, 1958; Schick, 1965), belonging to Shelford's Summer Drought or Broad Scle-

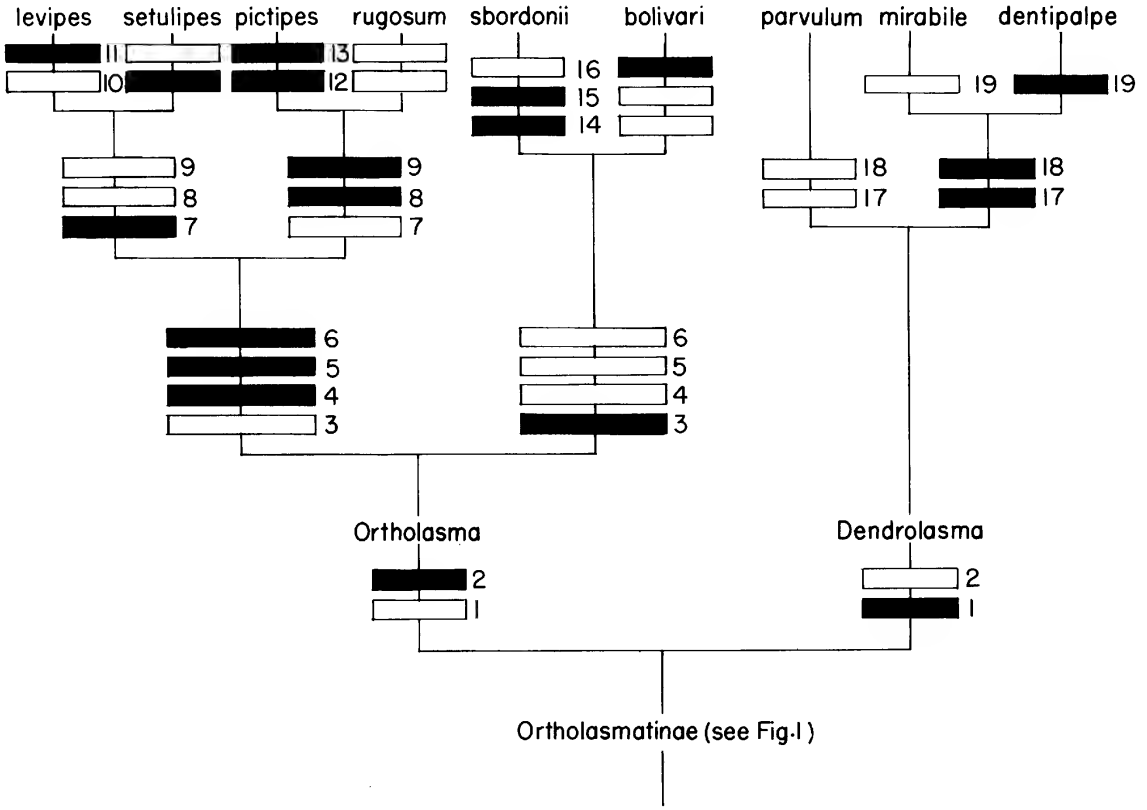


FIG. 2. Cladogram of the species of the subfamily Ortholasmatinae. See text for explanation.

rophyll–Grizzly Bear Biome, but we caution that the historical implications for this region drawn by Van Dyke (1919) and Linsley (1958), especially concerning a South American relationship, do not hold for our species.

The range of *Ortholasma bolivari* falls within the Transverse Volcanic Biotic Province of Mexico (Goldman and Moore, 1946).

The range of *Ortholasma rugosum* is not easily characterized in terms of the usual major provinces recognized in California, especially as it partakes of several of the provinces discussed by Schick (1965).

In a biogeographical view, especially as relates to invertebrates, the western part of North America differs from the eastern part. There are striking relict forms, endemism is higher and stronger intercontinental relations with Asia exist. Many of the lacunae in distributions in the western region are of recent origin and seem to be due to increased aridity in the area as a whole. In addition, broad arid stretches of country have separated the eastern and western part of North America, while a humid, perhaps hospitable Bering land bridge existed at several times in the Cenozoic (Hopkins, 1967). The Mexican highlands show relations to both regions and also retain older relicts (Knapp, 1965). In general, distributions of the type, eastern and/or western North America, central Mexico, and southern and/or northern Japan are known for numbers of plant and animal species. In the case of opilionids, we would mention the genera *Sabacon* [Europe, eastern, and western North America (Shear, 1975b), Japan (Suzuki, 1974), and the Nepal Himalaya (Martens, 1972)], *Taracus* (at least four species in western North America and one in eastern Siberia), *Crosbycus* [eastern North America, Japan (Suzuki, 1972)], caddids [eastern North America, Mexico, Japan

(Shear, 1975a; Suzuki, 1972)], and triaenonychids [eastern and western North America (Shear, 1977; Briggs, 1971), Japan (Suzuki, 1975)]. The genus *Leiobunum, sensu lato* is the most abundant and characteristic element of the opilionid fauna in the eastern part of North America, Mexico, and Central America, and in Japan. The same group is less important in Europe and western North America. In at least four cases (*Crosbycus dasycnemus, Caddo agilis, Caddo pepperella, Paranonychus brunneus*) the same species occurs in North America and in Japan. Strikingly, of the four named, only the last is found in western North America.

The other subfamily of the Nemastomatidae, Nemastomatinae, occurs in Europe and western Asia (Gruber and Martens, 1968; Gruber, 1976) and is strongly differentiated from Ortholasmatinae. This disjunction is probably old; Nemastomatinae is much richer in genera and species. The most strongly differentiated ones appear in Asia Minor, where in a parallel development with the ortholasmatines, "hoods" of a sort have appeared in at least one species (Gruber, 1976).

HISTORICAL SPECULATIONS: The present-day distributions of the species of ortholasmatines, especially in North America, have been profoundly influenced by the events of Pleistocene, including the advance and retreat of glaciers both continental and montane, and tectonic activity in the Southern Coast Ranges. In the last glaciation (Wisconsin), the continental ice sheet extended as far south as Puget Sound, with some possible small refugia existing in southern Alaska (Heusser, 1965; Frey, 1965; Wahrhaftig and Birman, 1965). In the south there were extensive montane glaciers. Climatic zones were shifted extensively; Martin and Mehringer (1965) have tried to reconstruct these changes. The present Washington State probably had a climate similar to the Alaska of today. In northern California there may have been refugial areas for forms limited to humid forests (Whittaker, 1961). In southern California, a much wider distribution of *Ortholasma* species would have been possible. Little is known about the influences of the Pleistocene glaciations on the Mexican highlands, but the southern part of Japan was probably little altered except for a shift in climatic zones southward and into lower altitudes.

As the continental and montane glaciers retreated, the devastated regions of Canada and probable former tundra areas in Oregon, Washington, and northern California became available for colonization by forest trees and by the forest-adapted *Dendrolasma* species and perhaps by *Ortholasma pictipes*. There is some possibility that *D. mirabile* might have survived in Alaskan refugia (see Shear's 1975b account of *Tomicomerus bryanti*), but we do not have really good records from southern Alaska or northern British Columbia. Meanwhile, in the south, drying of the central valley split the range of *O. levipes* and evidently restricted southern *levipes* and *setulipes* populations to canyons and other more mesic spots, though these two species (especially the latter) seem adapted to drier habitats in general.

Pre-Pleistocene influences are at the same time more interesting and more difficult to document. In particular, the differentiation of the subfamilies of Nemastomatidae points far into the past, certainly previous to the opening of the present Atlantic, to the supercontinent of Laurasia, and perhaps even to previous episodes of plate movements, but the biological effects of these are difficult to assess (see Bambach, Scotese, and Ziegler, 1980, for possible geographies of previous continental relations). The absence of relevant fossils leaves us with few clues, and the origins of these subfamilies may be so far in the past as to have been utterly obscured by subsequent events. In any case, our experiences and published research document the gap dividing the present American and European opilionid faunas.

The origins of the genera are likewise difficult to trace. *Dendrolasma* is clearly derived, and has a species in Japan. Is it possible that the genus originated in Asia from ancestors similar to *Ortholasma,* then extended its range across Beringia to America? Since *D. parvulum* (Japan) is in some ways the most primitive species of *Dendrolasma* and *D. dentipalpe* (northern California) the most derived, and because *Ortholasma,* a more primitive genus, is still found in North America but not (as far as we know) in Asia, we think this

possible. A possible scenario has the subfamily originating somewhere in America, very likely in a region north of the present Mexican highlands, and extending its distribution southward and northwestward. *Dendrolasma* might have originated from peripheral populations in present northeastern Asia, perhaps by saltational mechanisms now in vogue among macroevolutionists, and extended its range into unexploited habitats to the east. *Ortholasma* might always have been a somewhat dry-adapted group, and with the spread of mesophyll vegetation in the Pliocene (Wolfe and Leopold, 1967) could have been replaced by progressive *Dendrolasma* over the northern and western parts of its range. During glacial times, connecting populations of *Dendrolasma* would have been wiped out by ice sheets, montane glaciers, and the replacement of forests by tundra, leaving the present amphiberingian disjunction.

Ortholasma species make a nice south-to-north series, from the primitive *bolivari* and *sbordonii* in Mexico, to the derived *pictipes* in the northwest Pacific coast region. In fact, *pictipes* may represent a recent adaptation by *Ortholasma* populations to moist coniferous forests, an adaptation which has allowed its northward spread into the range of *Dendrolasma*. Herpetologists (Savage, 1960), entomologists (Ryckman, 1962; Ferguson, 1962; Halffter, 1964), and arachnologists (Rowland, 1972) have followed the hypotheses of Axelrod (1959), based on vegetational analysis, and documented a radiation northward from Mexico and the southwestern United States of faunal and floral elements of old Neotropical origin. This "neotropical-Tertiary" origin is balanced by the suggested "madro-Tertiary" migrations in the other direction. Our genus does not fit either of these schemes perfectly, since we have trouble suggesting an origin of the subfamily in the Neotropics. There are a few documented cases though of originally northern groups showing secondary radiations from the south (the *Rana boylei* group of frogs; see Zweifel, 1955). Perhaps the lack of ortholasmatines in eastern North America speaks for an absence from Mexico before Tertiary times, also.

Our *Ortholasma* scenario postulates a northerly origin, then a spread to the south, involving Mexico and perhaps relict regions in the southwestern United States. The series of more derived species encountered from south to north then can be established by a northerly radiation in the early to middle Tertiary, culminating in the appearance of the derived and differently adapted *pictipes*, perhaps during early glacial maxima.

In summary, we think that present species ranges reflect the events of the Pleistocene with, in some cases, restrictions and divisions by growing aridity, and in others, northerly range extensions into the advancing forests. The generic ranges and disjunctions are difficult to explain but the existence of a south-to-north series in *Ortholasma* suggests that the primitive subgenus *Trilasma* originated to the north of Mexico somewhere, moved south and north to differentiate into *Ortholasma* proper. *Dendrolasma* may have separated before these events, in all likelihood originating in Asia and colonizing back eastward through mesic forests. As for the separation of the subfamilies, this must have taken place very long ago. The opilionids are an ancient group and the families and subfamilies of today might have been established even before the appearance of Pangaea in the Late Permian.

TAXONOMY

FAMILY NEMASTOMATIDAE
SUBFAMILY ORTHOLASMATINAE, NEW

Trogulidae, Banks, 1894a, p. 11. Comstock, 1913, p. 79; 1940, p. 79. Roewer, 1923, p. 633 (in part); 1940, p. 26 (in part). Goodnight and Goodnight, 1942, p. 7; 1945a, p. 8. Suzuki, 1963, p. 40. Bragg and Leech, 1972, p. 70.

Ischyropsalidae (*sic*), Goodnight and Goodnight, 1945b, p. 6.

Ischyropsalididae, Roewer, 1950, p. 11 (in part). Ljovushkin, 1971, p. 130. Martens, 1972, p. 312.

Dicranolasmatinae, Šilhavý, 1967, p. 175 (in part). Suzuki, 1974, p. 121.

Nemastomatidae, Martens, 1969, p. 185.

TYPE GENUS: *Ortholasma* Banks, 1894a.

DIAGNOSIS: Nemastomatidae with combination of characters producing "trogulid facies"; dorsum flattened, free abdominal tergites shifted ventrally, hood formed by median process on eye tubercle and one or

two lateral processes of carapace on each side, hiding chelicerae and palps from dorsal view. With scutum parvum tending toward scutum magnum in two species, laterally with clearly defined lateral lamellae and pleural sclerites. Typical integumentary sculpture pattern or network of keel cells formed from elaborated anvil-shaped teeth. Chelicerae short, in males with basofrontal tooth on the second article. Palpi short, clavate hairs partially to strongly reduced in adults. Legs short, tarsomeres relatively few. Penis with characteristic long, stout stylus with dorsal membranous zone, glans with few setae. Ovipositor typical of family.

INCLUDED GENERA: *Ortholasma* Banks (=*Trilasma* Goodnight and Goodnight, *Ruaxphilos* Goodnight and Goodnight), *Dendrolasma* Banks (=*Cladolasma* Suzuki).

DISTRIBUTION: Western North America: highlands of central Mexico, Pacific coast from southern California north to coastal British Columbia (southern Alaska ?), foothills of the Sierra Nevada. One species in southern Japan (Shikoku).

KEY TO ADULT ORTHOLASMATINES

Adults differ from juveniles in having the characteristic cuticular sculpture, an open gonopore, and functional genitalia. Juveniles may be determined to species only with great caution: the youngest specimens must remain undetermined at present. Larger young (subadults or presubadults) may be placed in the proper genus if the lateral carapace processes of the hood are developed. Juveniles of *Ortholasma pictipes* develop the unique median stripe early. Overlapping ranges make geographical data difficult to use, and there are evidently some undescribed species. Clear association with adults and subsequent comparison is the only safe way to determine juveniles.

The questionable species *Ortholasma coronadensis* is not included in the key.

1. Frontal border of carapace on each side with two conical processes (fig. 19); penis with an apical hook (fig. 42) ..... *Ortholasma,* 2
   Frontal border of carapace with one process on each side (fig. 153); penis with spirally twisted apex (fig. 183) ..... *Dendrolasma,* 7
2. Median projection of hood with dorsal row of anvil or star-shaped tubercles (fig. 12); Mexico ..... subgenus *Trilasma,* 3
   Median projection of hood without such tubercles; United States and Canada ..... subgenus *Ortholasma,* 4
3. Surface-dwelling, dark in color, eyes normal; central Mexico ..... *bolivari* (Goodnight and Goodnight)
   Troglobitic, pale in color, eyes small, red, on stalks; caves in Tamaulipas, Mexico ..... *sbordonii* Šilhavý
4. Femora of legs banded, body with median light stripe; Mendocino Co., California, N to coastal British Columbia ... *pictipes* Banks
   Femora of legs not banded 5
5. Femora of legs without false articulations, appearing bumpy in outline (fig. 3); Coast Ranges N and S of San Francisco Bay ..... *rugosum* Banks
   At least second femora with false articulations, all femora appearing smooth in outline (fig. 5) 6
6. Microsculpture of leg femora appearing short-hairy (fig. 130), false articulations usually lacking on femora 1 and 3; southern California ..... *setulipes,* new species
   Microsculpture of leg femora granulate (fig. 104), all femora with false articulations; San Francisco Bay region S to Los Angeles, foothills of Sierra Nevada .. *levipes,* new species
7. Thorax with free metapeltidium; scute with large and small sculpture cells interspersed; Japan ..... *parvulum* (Suzuki)
   Scute more or less completely fused; scute cells either large (fig. 153) or small, but not both 8
8. Scute with dense network of small cells; legs short, banded; male palp with distal patellar tooth (fig. 194); northwestern California .. .. *dentipalpe,* new species
   Scute with larger cells; legs long, concolorous; male palp with enlarged patella (fig. 174), but no tooth; along the coast from southern Oregon to southern Alaska ... *mirabile* Banks

ORTHOLASMA BANKS, 1894

Ortholasma Banks, 1894a, p. 11 (type species *O. rugosum* Banks, by monotypy); 1901, p. 678; 1904, p. 363; 1911, p. 417. Comstock, 1913, p. 79 (not seen). Cockerell, 1916, p. 158. Hilton, 1919, p. 41. Roewer, 1923, p. 648. Schenkel, 1951, p. 47. Bragg and Leech, 1972, p. 71. Šilhavý, 1973, p. 191. Suzuki, 1974, p. 122. Shear, 1975b, pp. 8, 11 (in key). Martens, 1976, p. 66.

Trilasma Goodnight and Goodnight, 1942, p. 7 (type species *T. bolivari* Goodnight and Goodnight, by monotypy); 1945a, p. 8. Roewer, 1950,

p. 54. Suzuki, 1974, p. 122. Shear, 1975b, p. 11 (in key).

Ruaxphilos Goodnight and Goodnight, 1945, p. 299 (type species *R. petrunkevitchou* Goodnight and Goodnight, by monotypy); 1945b, p. 6. Roewer, 1950, p. 11. Ljovushkin, 1971, p. 130. Shear, 1975b, pp. 8, 10 (in key).

DIAGNOSIS: A genus of Ortholasmatinae with metapeltidium free from scute and carapace; with scutum parvum. Carapace with two processes on frontal border at each side of eye tubercle. Palpi of adults always with well-developed clavate hairs, more or less uniformly distributed. Glans penis with uniform setation (except in *O. sbordonii*), stylus ending in hook. All the above characters serve to distinguish *Ortholasma* from *Dendrolasma,* the only other genus recognized here.

DISTRIBUTION: Highlands of México, including outlying locality in Monterrey, Nuevo Leon; western North America from the southern border of California north mostly along the coast (one or two species in the Sierra Nevada foothills) to the southern border of the Alaskan panhandle.

RELATIONSHIPS: Compared to *Dendrolasma,* this genus seems more primitive in the clearer division of the dorsum, less flattened body, more highly arched hood, the greater retention of nymphal palpal setation (clavate hairs), and monomorphic glans spination (except in *sbordonii*).

SUBGENERA: It is possible to differentiate two species groups which may be considered subgenera.

Ortholasma, sensu stricto encompasses the Californian species, *rugosum, pictipes, levipes,* and *setulipes.* These species have the hood without dorsal tubercles; the males have an epigamic gland on the second cheliceral article.

Trilasma is formed from two species found in Mexico, *sbordonii* and *bolivari.* These species have anvil-shaped or three-pronged dorsal tubercles on the median hood process and lack cheliceral glands.

ETYMOLOGY: The genus name was probably formed by analogy with the name of the European genus *Dicranolasma,* and therefore should be considered neuter. Where required, we have changed the endings of the species epithets to agree with the gender of the generic name.

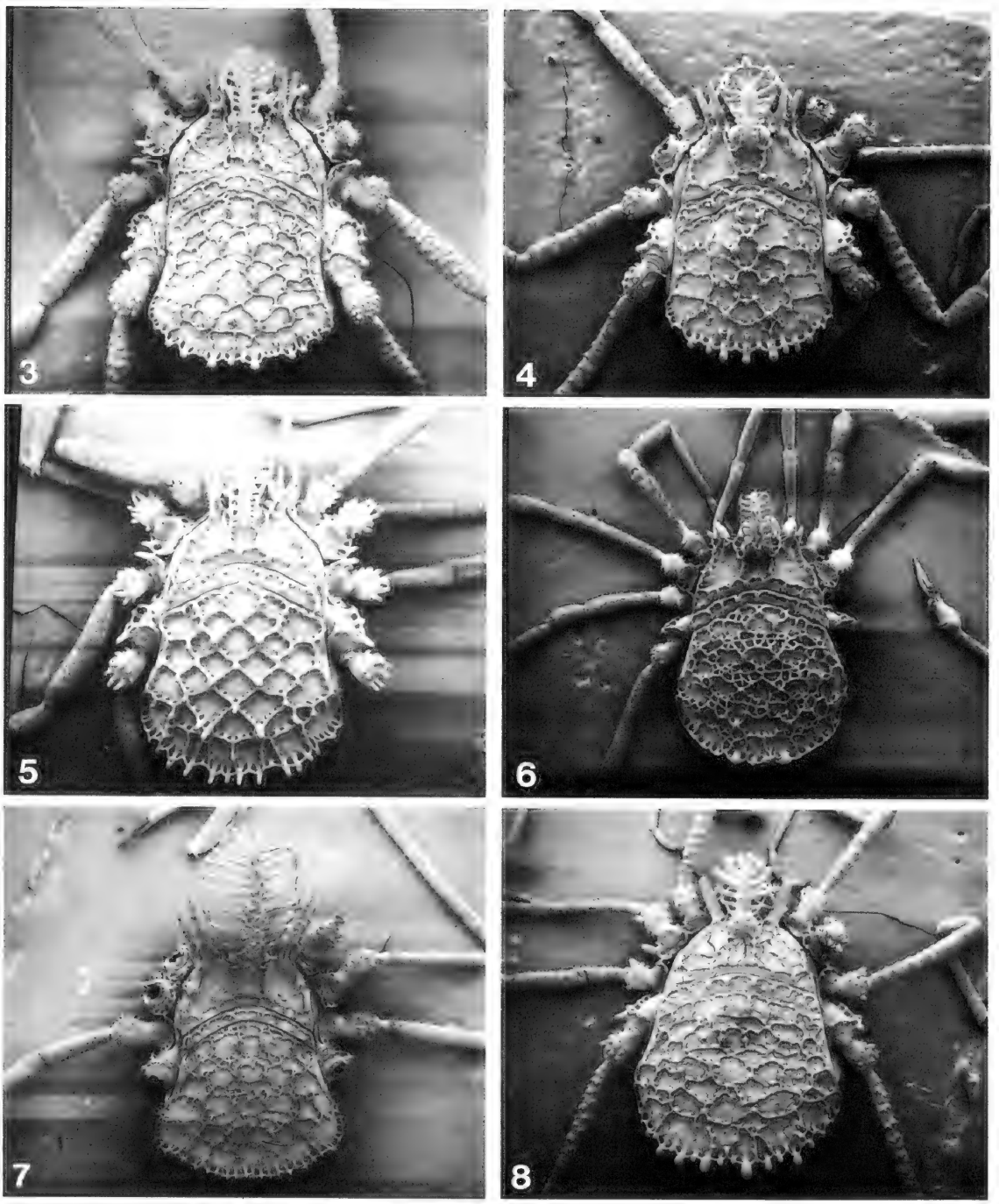
Ortholasma rugosum Banks
Figures 3, 9, 19–48; Map 1

Ortholasma rugosa Banks, 1894a, p. 12 (in part); 1901, p. 678 ("Washington" is an erroneous locality); 1904, p. 363, fig. 16 (in part, specimens from Alameda Co. belong here, those from Claremont to another species); 1911, p. 428, fig. 148c (in part, specimens from southern California belong to another species). Cockerell, 1916, p. 158. Roewer, 1923, p. 648, fig. 811 (in part; cites Banks's localities). Comstock, 1940, p. 80. Schenkel, 1951, p. 47. Roewer, 1950, p. 56.

TYPES: Lectotype male in MCZ, labeled by Banks as from "Southern California," but this is almost certainly an error. Banks's type series contained a male and female of *O. rugosum* (specimens that matched his description) and a female of *O. levipes.* The "cotypes" in the Roewer collection (SMF) are *O. rugosum.* To avoid future confusion, we have designated the male as a lectotype. This situation is discussed further under "synonymy" below.

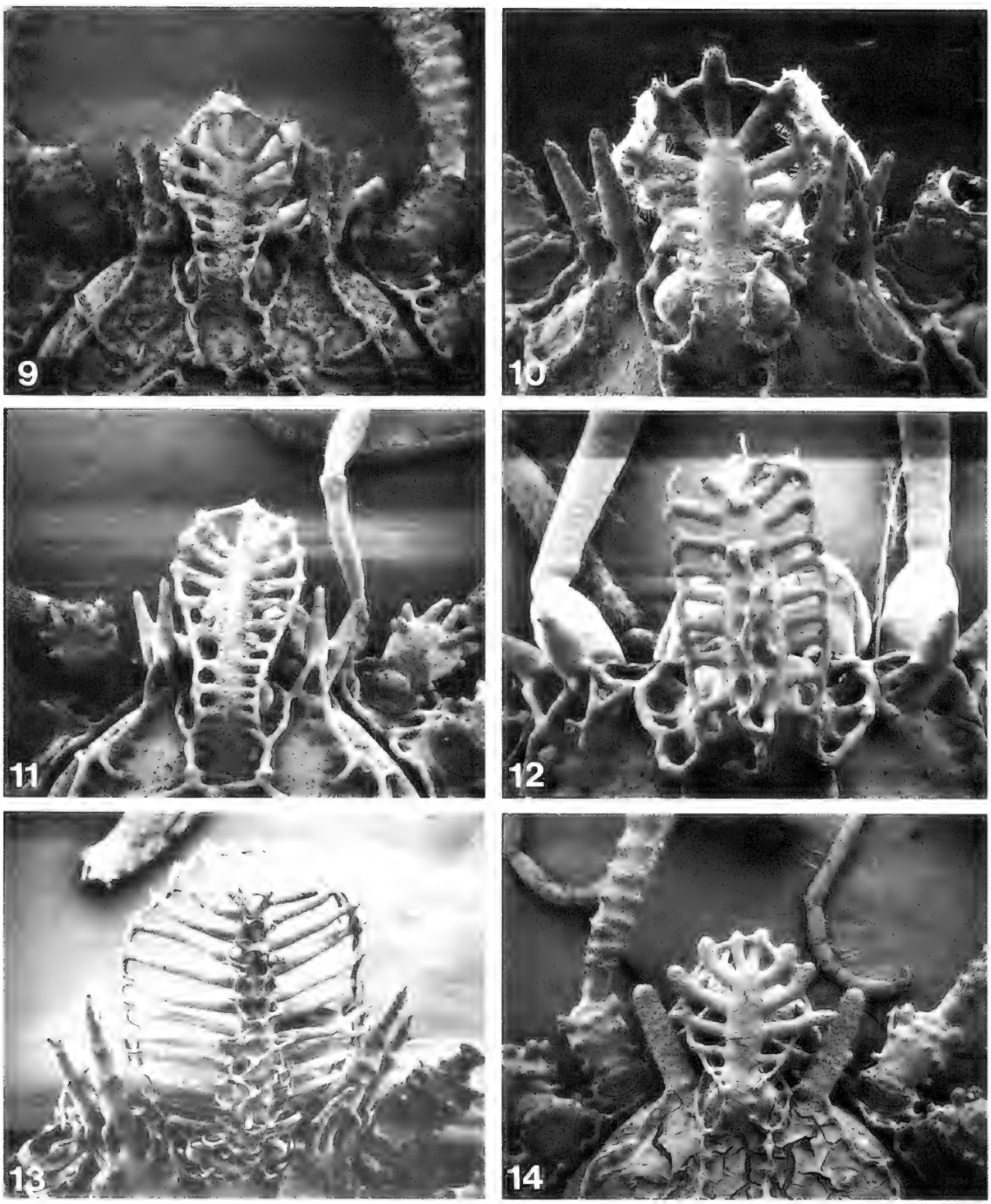
DIAGNOSIS: A species of *Ortholasma, sensu stricto* differing from all others in the combination of unbanded femora with a rough, tuberculate appearance lacking pseudoarticulations.

DESCRIPTION: Male lectotype (figs. 3, 19). Color uniformly brown, black rings around eyes, dorsal cuticle with some irregular darker speckles, abdomen slightly lighter in color in dorsal midline. Spines and tubercles lighter, some nearly white. Legs uniformly brown, somewhat paler distally. Cleaned scute shining, some parts lightly reticulated. Scute in dorsal view with sides nearly parallel, abdomen only slightly broader than cephalothorax. Metapeltidium separated from scute by narrow membranous fold. Hood (figs. 9, 22–28) with median process inserted dorsally on eye tubercle, evenly curved anteriorly, apex horizontal. Hood broadly spoon-shaped, maximum breadth about 2.5 times basal breadth, each side with about 10 fenestrations. Two small, conical teeth visible on dorsal side of median process. Eye lenses visible from above, but eyes hidden by keel. Front wall of carapace below hood with two transverse keels, upper one with a median rooflike crest; two vertical connecting keels. Laminae suprachelicerales normal, lateral ones with single small warts and median ones with short



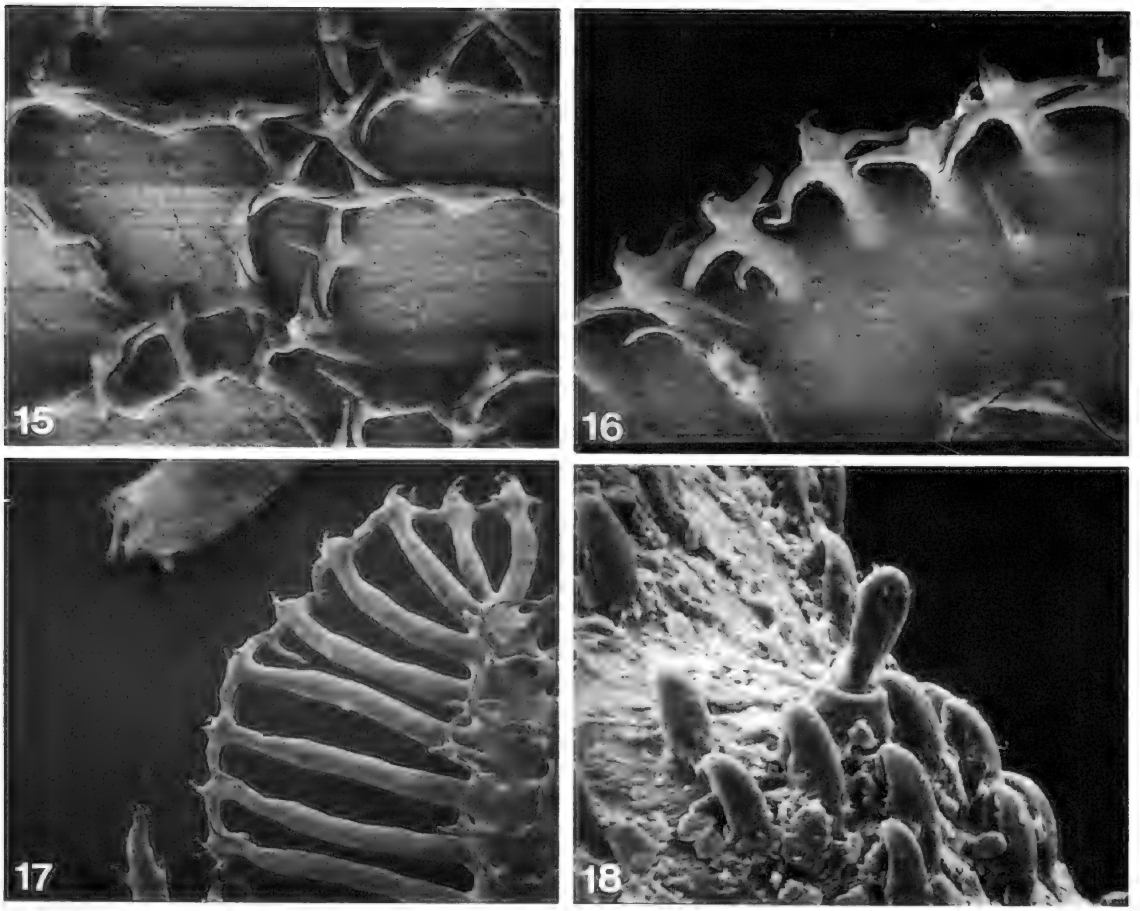
FIGS. 3–8. Scanning electron micrographs, dorsal views of male opilionids. 3. *Ortholasma rugosum,* 20×. 4. *O. pictipes,* 18×. 5. *O. setulipes,* 19×. 6. *O. bolivari,* 20×. 7. *O. sbordonii,* 19×. 8. *Dendrolasma mirabile,* 25×.

row of teeth. Dorsal pattern of keels as usual, keels well elevated above dorsum. At intersection points and projecting points of thorax keel pegs elongated, but not as spines, form-



FIGS. 9–14. Scanning electron micrographs, dorsal views of hoods of male opilionids. 9. *Ortholasma rugosum,* 50×. 10. *O. pictipes,* 68×. 11. *O. setulipes,* 50×. 12. *O. bolivari,* 50×. 13. *O. sbordonii,* 50×. 14. *Dendrolasma mirabile,* 50×.

ing blunt, pommel-shaped, granulate heads, rising only slightly above keels. Free tergites with more or less reduced, interrupted transverse rows of teeth or tubercles, tergite 8 with

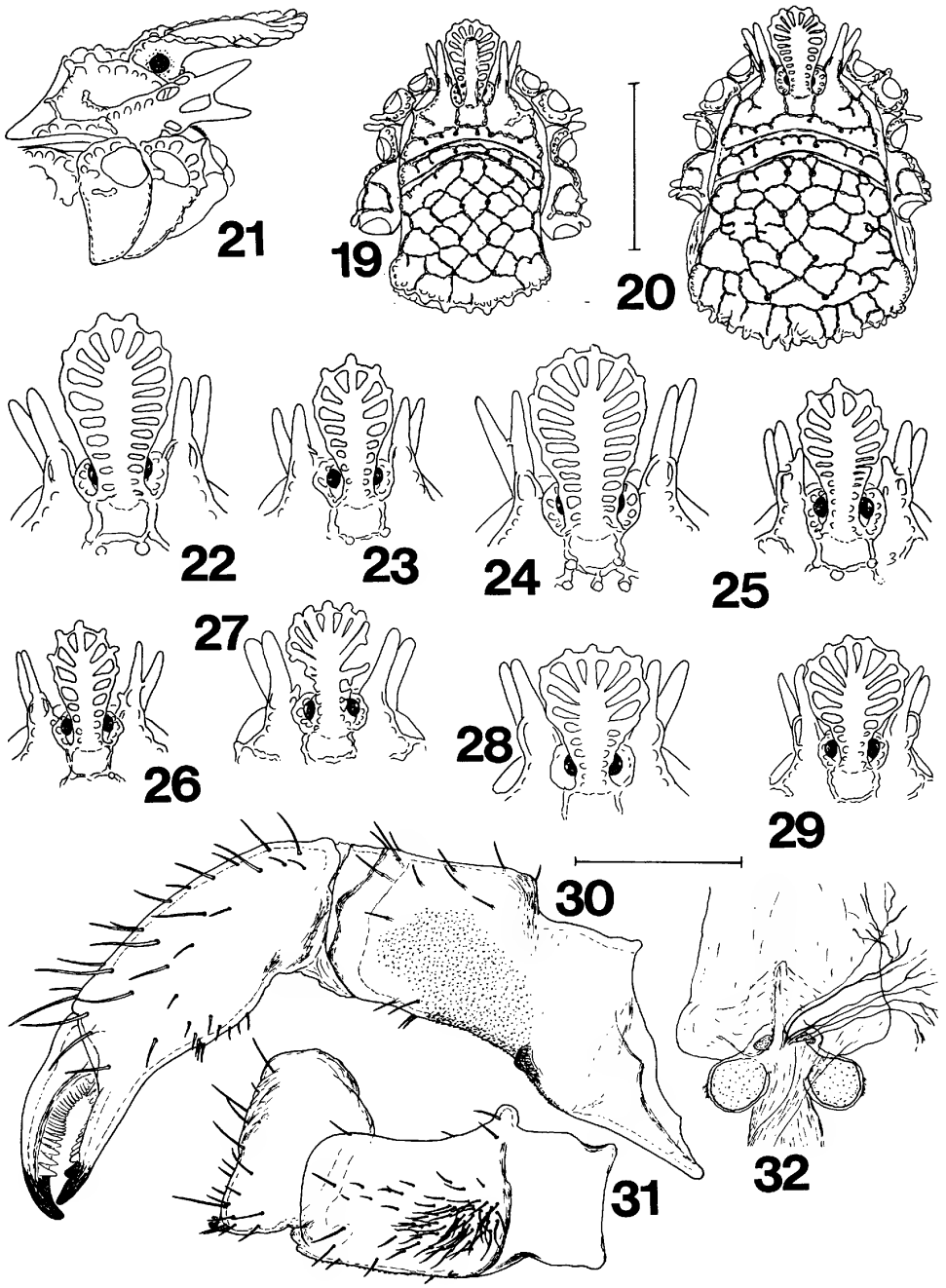


FIGS. 15–18. Scanning electron micrographs. 15. Dorsal view of star-shaped tubercles from dorsal scute of *Ortholasma sbordonii,* 200×. 16. Oblique view of posterior marginal tubercles of scute of *O. sbordonii,* 200×. 17. Dorsal view of tubercles of median hood process of *O. sbordonii,* 150×. 18. Microsculpture of first leg femur of *O. pictipes,* 1300×.

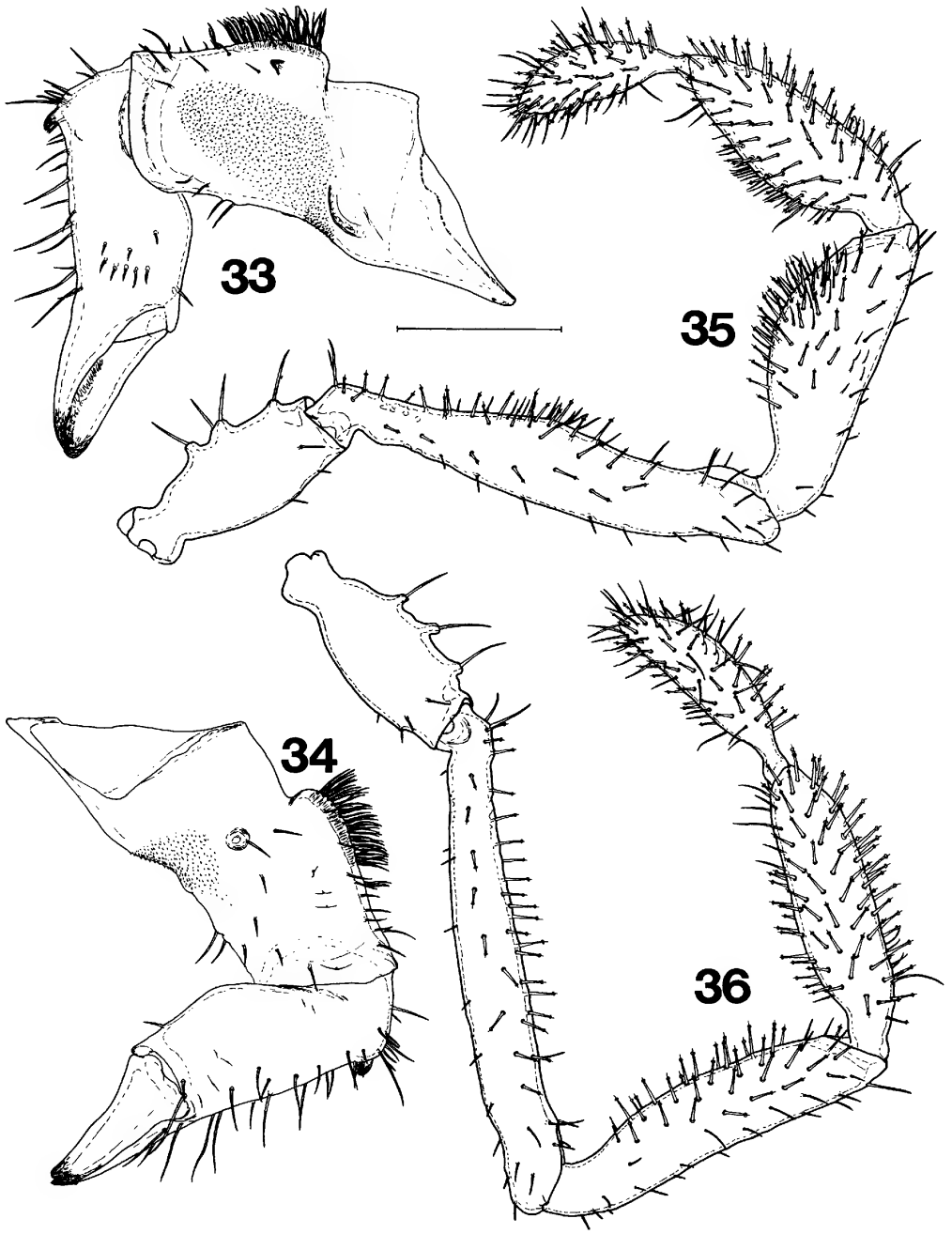
remnants of keels anteriolaterally. Corona analis with tubercles. Free sternites with rows of hair-tipped tubercles. Genital operculum tongue-shaped, apical tip hardly discernible. Coxal surfaces like sternites. Pleural sclerites well developed.

Chelicerae as in figures 31, 33, 34. Basal article with small tooth distally, dorsomedial areas of glandular tissue, often with secretions still adhering; distal article with normally developed frontal tooth. Pedipalp as in figure 35, trochanter with three to five ventral warts with long setae; femur relatively stout, length to thickness *ca.* 5.6–6.6 mm., ventral side with slightly convex contour about at midpoint, opaque glandular tissue occurs under cuticle here, coagulated secretions may be seen adhering to small hairs between clavate hairs, clavate hairs distributed disto-medially; dorsal femora with short, acute setae. Patella three times as long as thick, with clavate hairs; glandular tissue and coagulated secretions present on enlarged part. Tibia stalked, pear-shaped, three times as long as thick, with clavate hairs and glandular tissue. Tarsus stalked, oval, with clavate hairs and typical setation.

Legs with trochanters tuberculate, bearing short club-shaped setae. Femora strong and stout, first and third somewhat spindle-

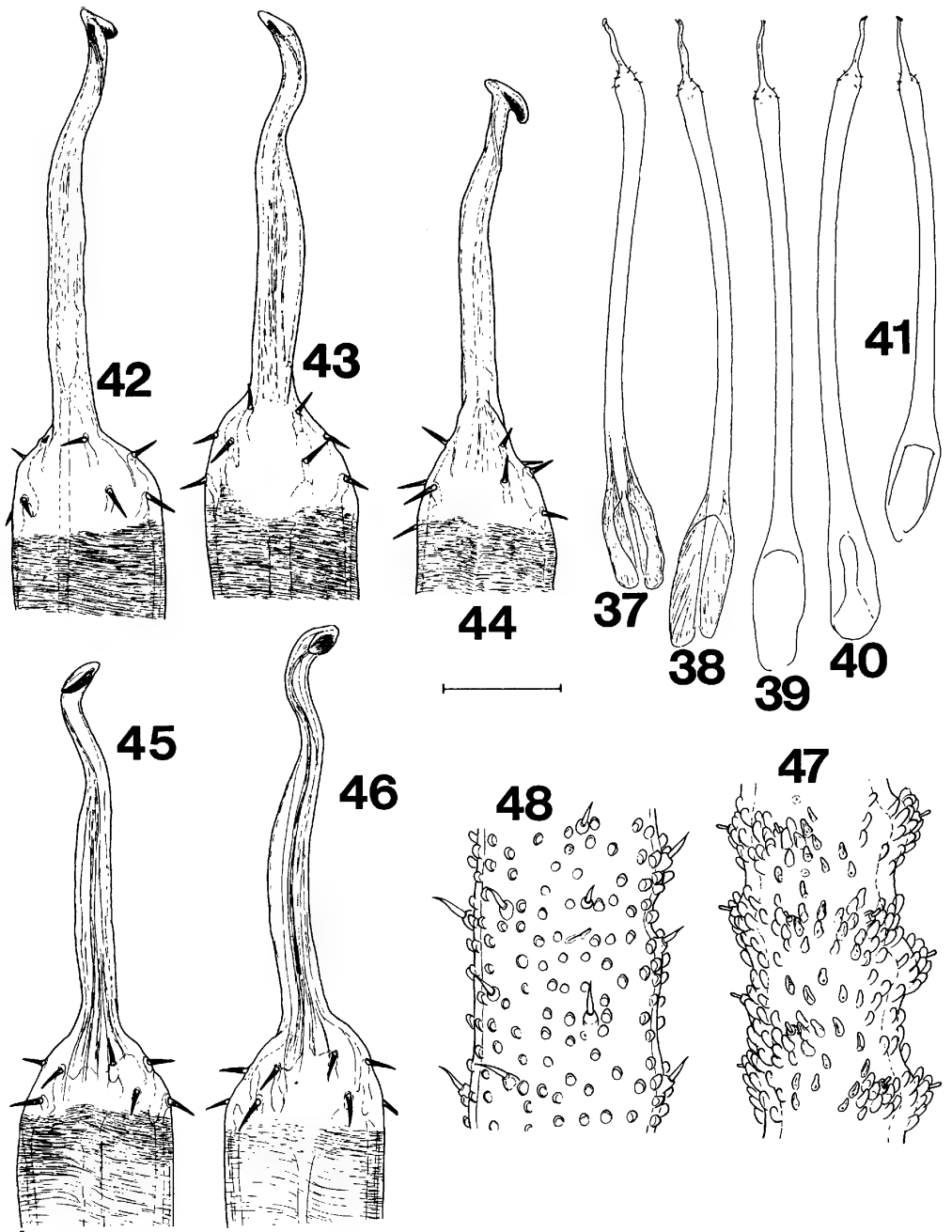


FIGS. 19–32. *Ortholasma rugosum.* 19. Male from Glen Ellen, dorsal view of body. 20. Female from Boulder Creek, dorsal view of body. 21. Anterior end of male from Glen Ellen, lateral view. 22–29. Dorsal views of hoods. 22. Male from N Santa Rosa. 23. Male from Gualala. 24. Male from Cordelia. 25. Male from Bolinas Ridge. 26. Another male from the same Bolinas Ridge collection. 27. Male from 6 miles SE of Half Moon Bay, showing hood possibly damaged in molting or in previous instar. 28. Another male from the same population, showing a normal hood. 29. Female from Bolinas Ridge. 30. Right chelicera of female, mesal view. 31. Right chelicera of male, dorsal view. 32. Seminal receptacles. Scale lines = 2.00 mm. for figures 19, 20; 1.0 mm. for figures 21–29; 0.35 mm. for figures 30, 31; 0.18 mm. for figure 32.



FIGS. 33–36. *Ortholasma rugosum*. 33, 34. Right chelicera of male. 33. Mesal view. 34. Lateral view. 35, 36. Right pedipalps, mesal views. 35. Male. 36. Female. Scale line = 0.25 mm.

shaped, fourth less thick, second slender and cylindrical; contours roughened by bumps, no pseudoarticulations. Metatarsi slender, less than half as thick as tibiae, second metatarsi



FIGS. 37–48. *Ortholasma rugosum*. 37–41. Views of penes. 37. Woodside, ventral. 38. Fort Ross, dorsal. 39. Gualala, dorsal. 40. Davenport Quarry, ventral. 41. Near Pescadero, dorsal. 42–46. Tips of penes. 42. Gualala, dorsal. 43. Fort Ross, dorsal. 44. Near Pescadero, dorsal. 45. Bolinas Ridge, ventral. 46. Point Reyes Station, ventral. 47, 48. Microsculpture of second leg femur. 47. Adult male, Fort Ross. 48. Subadult, Bon Temps Lake. Scale line = 0.44 mm. for figures 37–41; 0.1 mm. for figures 42–46; 0.15 mm. for figures 47, 48.

with pseudoarticulations 7/7 in lectotype, two apical articles movable. Tarsal numbers: 10(8+2)/8(6+2)–14(12+2)/13(11+2)–8(4+2+2)/9(5+2+2)–9/10(6+2+2). Leg microsculpture as shown in figures 47 and 48. Femora with small, thick, conical, blunt denticles, somewhat larger ones clumped in groups around major setae. Setae blunt, club-shaped. Denticles on apical part of article more compressed, trend continues on patellae and tibiae, on tibiae denticles are more compressed still and more acute; small setae are longer on tibae and more acute. Metatarsi and tarsi with dense cover of microtrichia and scattered, longer acute setae.

GENITAL MORPHOLOGY: Penis (figs. 37–41) with slender shaft, glans slightly asymmetrical, narrowing with convex contour from base of stylus, with six pairs of slender, conical setae. Stylus 3 to 3.5 times as long as glans, apical part (figs. 42–46) slightly bent into sigmoid curve, ending in ventrally deflected hook.

Female from Boulder Creek: Differing from male in body proportions (fig. 20). Genital operculum broad, transversely blunted, with apically excavated lip. Chelicerae (fig. 30) without glandular areas and teeth. Femora and patellae of palpi (fig. 36) not swollen, lacking small acute hairs and glandular areas. Legs more slender than in males; tarsal numbers 8–13–9–9; metatarsi 2 with eight or nine pseudoarticulations. Genital morphology: Ovipositor normal, furcal sclerites with long setae. Seminal receptacles as in figure 32.

MEASUREMENTS: All measurements are in millimeters:

MALE LECTOTYPE: Total length, 4.5. Scute length, 3.6. Width of abdomen, 2.2, leg femora 1–4 1.6, 3.4, 1.9, 2.6 long, respectively.

Male from Glen Ellen, California: Total length, 3.8. Scute length, 3.1. Width of abdomen, 2.0. Appendages as in table 3.

Female from Boulder Creek, California: Total length, 4.8. Scute length, 3.4 Width of abdomen, 2.8. Appendages as in table 4.

VARIATION: Variations in meristic characters are summarized in table 5. The males show greater variation in meristic characters than do the females; relative leg lengths are smaller in larger males.

There is no significant variation in color pattern. As far as the keel patterns are concerned, in some few specimens the frontal keels of the carapace break up into isolated teeth, and in a few others the dorsal keels of the carapace are very much reduced or even absent. In the case of the hoods (figs. 21–29) three types may be recognized, though there are intergrades among them. "Large" hoods have a spoon-shaped outline, are widest in the frontal third, about 2.25 times wider than the base just above the eyes, and have eight to 11 (mostly 10) fenestrations on each side in males; six to 10 (mostly nine) in females. "Small-broad" hoods are rounded to transversely truncated on the rostral border, up to three times as broad near the tip as above the eyes, have six to eight fenestrations in males, six to 10 in females making a transition to "large" hoods. "Small-narrow" hoods are spoon-shaped but narrower and shorter than the "large" type, with six to 10 (mostly seven) fenestrations in males, five to eight (mostly six) in females. Sometimes, as in the lectotype, there are two or three small warts dis-

TABLE 3
Leg and Palpal Segments of Male *Ortholasma rugosum* from Glen Ellen
(Measurements in millimeters.)

	LEGS				
SEGMENT	1	2	3	4	PALPUS
Trochanter	—	—	—	—	0.38
Femur	1.5	3.0	1.6	2.3	0.81
Patella	0.5	0.7	0.6	0.8	0.59
Tibia	1.0	2.6	1.2	2.1	0.48
Metatarsus	0.9	2.4	0.8	1.2	—
Tarsus	1.1	2.2	1.1	1.3	0.32

TABLE 4
Leg and Palpal Segments of Female *Ortholasma rugosum* from Boulder Creek
(Measurements in millimeters.)

	LEGS				
SEGMENT	1	2	3	4	PALPUS
Trochanter	—	—	—	—	0.42
Femur	1.5	3.3	1.8	2.5	1.00
Patella	0.8	0.8	0.6	0.8	0.68
Tibia	1.1	2.7	1.4	2.2	0.56
Metatarsus	1.0	2.5	0.9	1.3	0.41
Tarsus	1.0	2.1	1.1	1.3	0.41

TABLE 5
Variation in Meristic Characters in *Ortholasma rugosum*
(Measurements in millimeters.)

MEASUREMENT	RANGE	MEAN AND S.D.
Total body length:		
Males (n = 40)	2.8–4.7	3.44 ± 0.46
Females (n = 31)	3.4–4.7	4.04 ± 0.32
Scute length:		
Males	2.3–3.8	2.79 ± 0.38
Females	2.8–3.9	3.35 ± 0.29
Breadth of abdomen:		
Males	1.5–2.5	1.91 ± 0.25
Females	2.0–3.0	2.49 ± 0.27
Length of femur 2:		
Males	2.3–3.4	2.82 ± 0.26
Females	2.5–3.4	2.85 ± 0.26
Penis length (n = 8)	1.78–2.13	1.90
Total length/length less hood:		
Males	1.12–1.29	1.23
Females	1.13–1.27	1.21
Total length/breadth of abdomen:		
Males	1.65–2.05	1.80
Females	1.40–1.81	1.62
Total length/length of femur 2:		
Males	1.00–1.43	1.22
Females	1.22–1.74	1.42

tally on the dorsal side of the median hood process. A few specimens had damaged hoods perhaps resulting from difficulties in molting.

There appears to be no correlation between size and the numbers of tarsomeres, since even small specimens can have high counts.

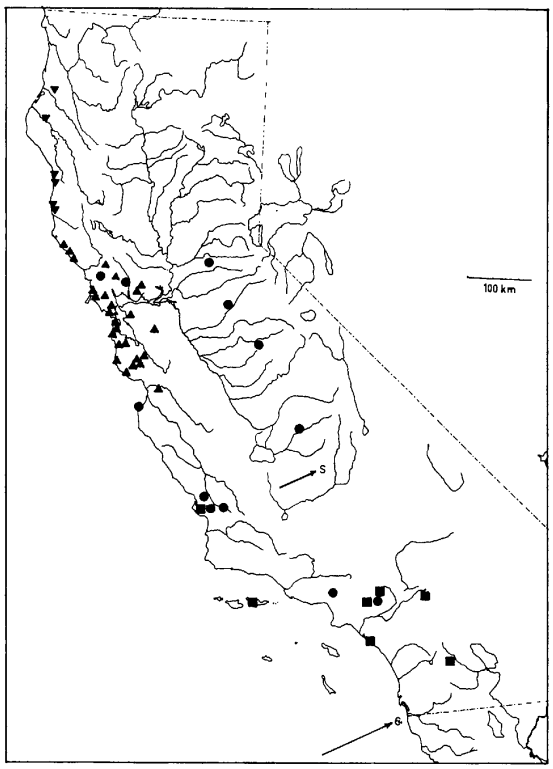
Looking at variation from a geographic viewpoint, smaller animals prevail in the western and northwestern parts of the species range. Specimens from Marin Co., California, have relatively longer legs and narrower hoods, whereas those from Half Moon Bay, Pescadero Creek, and other localities are small, with shorter hoods that are even more depressed. Some of these small animals with short, narrow hoods also have median lighter stripes that are quite distinct, and may result in some confusion with *O. pictipes* if other characters are not kept in mind. Larger specimens come from more easterly, inland locations, for example, Santa Rosa, Berkeley, Alameda Co., and in the southeastern part of the range from Santa Cruz, Santa Clara, and San Benito counties. In the large males, the legs are relatively shorter, but no such correlation occurs in the females. Large hoods and uniformly dark coloration predominate among these specimens—they resemble the lectotype closely. These variations may have an ecological basis, but considering the complex interdigitation of the different habitats in this region, no conclusions can be drawn unless the situation is examined very closely.

JUVENILE STAGES: Only two subadults of this species have been studied. The eye-mounds have a thick, club-shaped process rising obliquely rostrad, with apical, and three to five lateral, tubercles. The roughened character of the legs has already appeared at this stage. Both specimens are light in color.

RELATIONSHIPS: *Ortholasma rugosum* appears to be closest to *O. pictipes*. The hoods of some *rugosum* are *pictipes*-like, and this often is correlated with a *pictipes*-like stripe on the abdomen. Both species have glandular, swollen areas on the palpal femora and patellae, and roughened leg femora without pseudoarticulations. On the other hand, the species pair *levipes-setulipes* has an entirely different pattern of leg microsculpture, and the femora have pseudoarticulations. Under "unassigned specimens" below, we briefly discuss a single female specimen from California Hot Springs which resembles *rugosum* in some respects and may be a third species related to *rugosum* and *pictipes*.

DISTRIBUTION: See map 1. This species has a rather restricted range in western central California—the Coast Ranges north and south of San Francisco Bay, reaching to Mendocino Co. in the north, where the range seems to adjoin the range of (the vicariant?) *O. pictipes*. In the east, the range of *rugosum* appears to be limited by the arid Central Valley. The species is certainly absent from southern California, calling into question the original data provided by Banks (1894a) and since repeated by others. The bionomic provinces and districts suggested by Schick (1965) do not seem to be very suitable for describing the range of this species, since its distribution partakes of several of them.

RECORDS: CALIFORNIA: *San Benito Co.:* 3 mi. NW San Juan Bautista, Feb. 28, 1967



MAP 1. California, showing distribution of *Ortholasma* species. Dots, *O. levipes.* Squares, *O. setulipes.* Triangles, *O. rugosum.* Inverted triangles, *O. pictipes.* Further localities for *O. pictipes* shown on map 2. *S* marks locality of suspected new species from California Hot Springs; *C* marks locality of *O. coronadense.*

(T. Briggs, V. Lee), ♂, ♀ (CAS); Feb. 26, 1967 (V. Lee), juv. (CAS). *Santa Clara Co.:* E side Mt. Madonna, Jan. 8, 1966 (T. Briggs), ♀ (CAS); 0.9 mi. S junction Silver Creek and San Felipe roads, Nov. 27, 1966 (K. Hom), ♀ (CAS); 2 mi. N Daly City, Dec. 6, 1966 (V. Roth), ♂ (AMNH); Stevens Creek, June 2, 1957 (R. Schuster), ♂ (AMNH); near Davenport Quarry, June 11, 1966 (T. Briggs, V. Lee), 4♂♂, 3♀♀ (CAS). *Santa Cruz Co.:* 6 mi. NE Boulder Creek, Aug. 28, 1957 (I. Newell), ♀ (AMNH). *San Mateo Co.:* 6 mi. SE Half Moon Bay, July 21, 1957 (R. O. Schuster), 6♂♂ (AMNH); Pescadero Creek, SE Half Moon Bay, April 26, 1959 (R. Schuster), ♂, ♀ (AMNH); 1.8 mi. E junction Cloverdale and Canyon roads, July 5, 1965 (L. Lee, T. Briggs), ♂ (CAS); Linda Mar, Pacifica, Feb. 7, 1967 (T. Briggs, V. Lee), ♂ (CAS); San Bruno Mts., July 6, 1966 (T. Briggs), ♀ (CAS); 1.1 mi. NE Woodside, Aug. 28, 1957 (I. Newell), ♂ (AMNH). *San Francisco Co.:* San Francisco, no date (G. Marx), ♂ (USNM). *Alameda Co.:* Corral Hollow, near Livermore, May 8, 1965 (T. Briggs), 2♀♀ (CAS); Berkeley Hills, no date or collector, ♀ (CAS). *Solano Co.:* Cordelia, Feb. 20, 1929 (O. F. Cook) 2♂♂, ♀ (USNM). *Marin Co.:* N Toll Station, Bolinas Ridge, July 17, 1965 (V. Lee, T. Briggs), ♂, 3♀♀ (CAS); Phoenix Lake, May 14, 1966 (V. Lee), ♀ (CAS); Taylorville, Dec. 28, 1919 (H. Dietrich), ♀ (AMNH); outside Muir Woods, Jan. 10, 1964 (V. Roth, P. Craig), ♂, ♀ (AMNH); 6 mi. E Point Reyes Station, March 1, 1960 (R. Schuster), ♂ (AMNH); Inverness, May 16, 1952 (H. Leech), ♀ (CAS), near Tomales Bay State Park, Feb. 6, 1966 (T. Briggs), ♀ (CAS). *Sonoma Co.:* Redwood grove near bridge on Chalk Hill Rd., 5.8 mi. NE junction Pleasant and Chalk Hill avenues, 8 mi. N. Santa Rosa, May 21, 1966 (V. Lee), 2♂♂ (CAS); 3 mi. S Ft. Ross, July 19, 1962 (V. Roth), ♂ (AMNH); 3 mi. W Plantation, Feb. 12, 1966 (K. Hom, T. Briggs), ♀ (CAS); 0.75 mi. E Bon Temps Lake, Apr. 3, 1966 (K. Hom, T. Briggs), juv. (CAS).

ECOLOGY: We have to limit our remarks to the information we have gathered from the sparse notes on collectors' labels. Most specimens were taken on the ground, sieved from litter, found under stones or logs, or under bark. In 13 samples, vegetation was mentioned. In six of these, redwood was said to predominate, one came from California Laurel near a redwood forest, and one each from "Bishop Pine," "oak woodland," "hill grassland," and "coastal scrub." Two samples came from "oak woods." Perhaps this species is able to use habitats ranging from closed redwood forests to grasslands.

SYNONYMY: At least two species have been referred to under this name, so the correct placement of citations is difficult, especially since some authors simply relied on the older literature without critically examining specimens. Even the original description seems to have been based on a mixed sample (see "types" above). We think Banks (1894a) called the true *rugosum* in his sample "adults" and then included *levipes* (newly described in this paper) as "young specimens." Shear

(1975a) pointed out a similar situation in Banks's original description of *Caddo agilis*. We have designated a lectotype male from the type series and suggest that the type locality given by Banks, though exceedingly broad ("Southern California"), is even so in error and really should be Central California. Banks's 1901 citation of the species for Washington State is certainly a mistake; maybe he meant *pictipes*, the nearest relative of *rugosum*.

Ortholasma pictipes Banks

Figures 4, 10, 49–74; Maps 1, 2

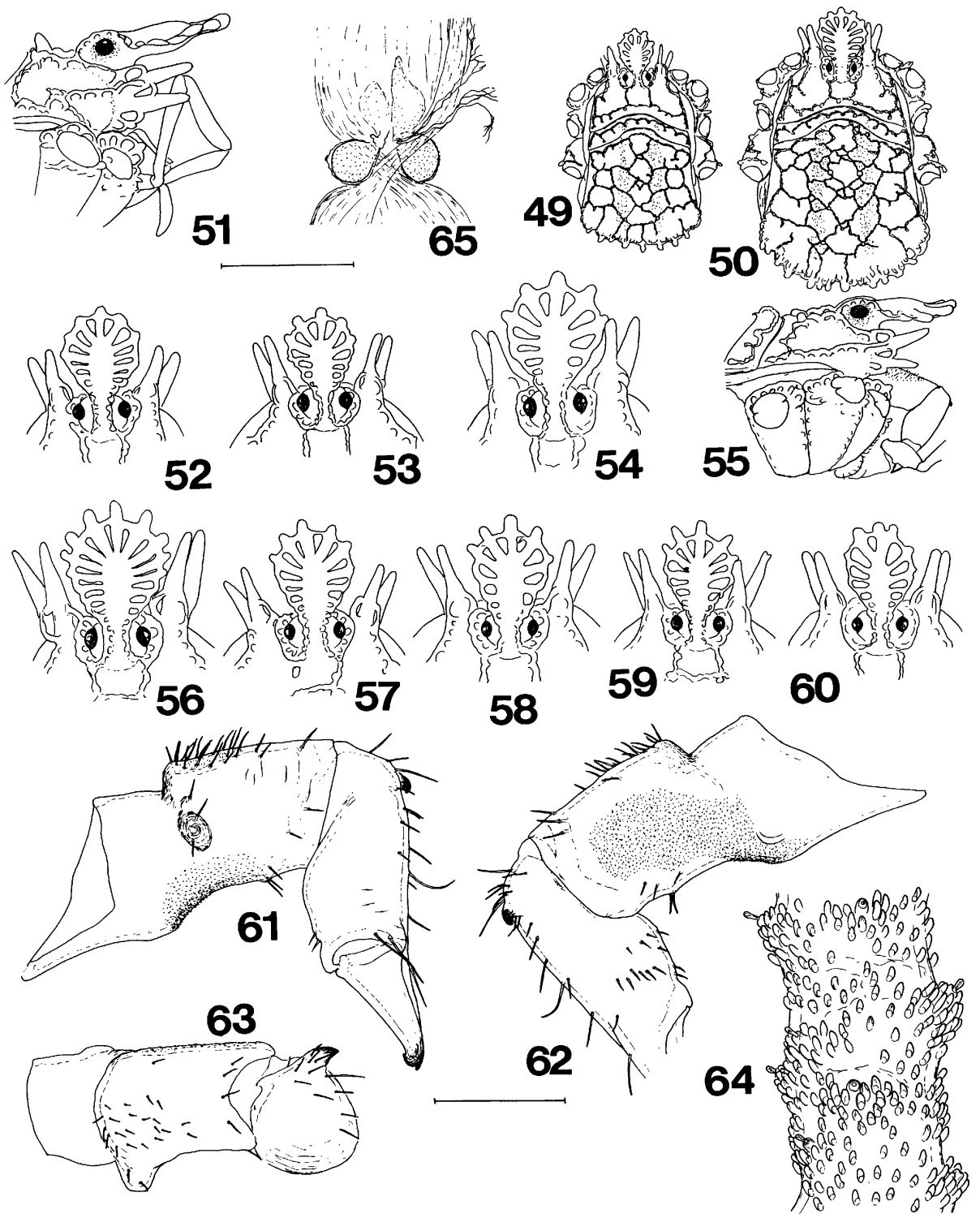
Ortholasma pictipes Banks, 1911, p. 417, fig. 148. Comstock, 1940, p. 79, fig. 59. Roewer, 1923, p. 649, fig. 812. Bragg and Leech, 1972, p. 71.

TYPES: Female holotype from "Mt. Wilson, Calif." (MCZ). Again, as in the preceding species, Banks (1911) seems to have engendered confusion as to the locality at which the type was collected. In his original description he gives both Humboldt Co. and Mt. Wilson, California, as "type localities." We could not find the Humboldt Co. specimen; the "Mt. Wilson" female in the MCZ is labeled "Ortholasma pictipes Bks. type," "Specimen figured," and "Mt. Wilson 4 Sept (illegible)." The two localities cited are far apart. Mt. Wilson is, in fact, far outside the range of *O. pictipes* as we have established it, and the species has never been collected again in southern California. Gruber wrote to the collector, Prof. Chester Bradley, in 1971 and he confirmed that he had collected in Humboldt County in June of 1907, and on the summit of Mt. Wilson in September of that year. Prof. Bradley was known as a meticulous collector and we doubt that he could have exchanged material from these two localities. Two possible sources of error lie in the fact that the specimens were transmitted to Banks by J. H. Comstock, who might have inadvertently mixed the material, and, of course, in the picture that is emerging of Nathan Banks, like many of his contemporaries, as a none-too-careful curator. In any case, despite the occasional disjunction of a northern California species on a southern California mountaintop, we are not inclined to accept the Mt. Wilson locality for *O. pictipes*. We restrict the type locality, therefore, to Humboldt Co., California.

DIAGNOSIS: A California species of *Ortholasma, sensu stricto* most closely related to *O. rugosum*, from which it may be separated by having distinctly banded legs and a median light stripe on the body. It differs from the other two California species in lacking false articulations in the femora of the legs.

DESCRIPTION: Male from Del Norte Coast Redwoods State Park (fig. 49): Color pattern distinctive. Scute, especially the abdominal part, with median light longitudinal band, bounded on each side by distinctly darker zone, growing pale again at lateral margins. Black rings around eyes; eye tubercle and hood pale tan. Venter dark brown, slightly lighter in ventral midline. Legs transversely banded; trochanters dark brown with pale tubercles, femora basally with light band, followed by dark band, then pale near the midlength, dark again, then light with a narrow dark apex. Patellae basally dark, apically light. Tibiae banded, dark–light–dark–light–dark. Metatarsi and tarsi uniformly brown. Scute dorsally flattened, sides subparallel. Hood (figs. 52–55, 59, 60) relatively low, depressed; median process of eye tubercle inserting broadly on rostral part, extending strongly forward, only slightly angled dorsally. Eyes completely visible from above due to rostral position of median process. Hood with five fenestrations on each side, lateral processes not extending much beyond their T-shaped heads. Front wall of carapace below hood with only one transverse keel. Two large lateral processes on each side connected to subocular keel and to each other. Pattern of scute keels conforming to *rugosum* type, but more coarsely toothed, more angular and less clearly ordered. Keel pegs more spinelike than in *rugosum*, where they are elongated above keels. Genital operculum as usual, apically narrowed, tongue-shaped.

Chelicerae (figs. 61–63) like those of *O. rugosum*, but basal article with larger peg, hairs of glandular area more scattered; coagulated secretions often present. Pedipalps as in figures 66, 68–70; trochanters ventrally with four or five seta-bearing warts; femora relatively stout, about 5..7 times as long as thick, ventral side in middle slightly inflated, with glandular tissue, clavate hairs in ven-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tromedian region; patellae ventrally inflated, about 3.4 times as long as thick, hairs as in femur; tibiae and tarsi as in *rugosum*.

LEGS: Trochanters with rounded tubercles bearing blunt, club-shaped setulae; femora 1 and 3 thickened, femur 4 less so, femur 2 slender, cylindrical, without pseudoarticulations. Femoral contours roughened by bumps, tibiae less so, lacking pseudoarticulations. Microsculpture as in figure 64; blunt, club-shaped setulae on small papillae somewhat raised above general surface, denticles broad, blunt-conical, grouped around setal bases to form bumps, smaller denticles dispersed over surface, zones of sparse microsculpture appear to be (but are not) pseudoarticulations; distally, especially on tibiae, denticles more compressed, more acute, hairs likewise. Metatarsi and tarsi with microtrichia. Metatarsi 2 with pseudoarticulations 9/9, apical ones movable. Tarsal numbers: 10–16/15–9/10–8/9.

GENITAL MORPHOLOGY: Penis (figs. 71–74) quite similar to that of *O. rugosum*, shaft somewhat stouter; glans with variable proportions; stylus about two or three times as long as glans proper.

Female from Miranda, California (fig. 50): Differing from male in proportions and measurements, as given below. Genital operculum broadly rounded, with shining lip apically, and small, transverse oval excavation. Chelicerae without modifications found in male. Palpi (fig. 67) with more slender femora than in male (about 7.3 times as long as thick), ventrally not inflated, without glands; patellae 4.6 times as long as thick, without ventral swelling and glands; tibiae and tarsi as usual, densely set with clavate hairs. Legs much as in male; metatarsi 2 with 8/6 pseudoarticulations. Tarsal numbers: 6/8–11/11–8/8–8/8. Ovipositor as usual; seminal receptacles (fig. 65) one large round sac and one distal, smaller saccule on each side.

TABLE 6

Leg and Palpal Segments of Male *Ortholasma pictipes* from Del Norte Coast Redwoods State Park

(Measurements in millimeters.)

	LEGS				
SEGMENT	1	2	3	4	PALPUS
Trochanter	—	—	—	—	0.36
Femur	1.3	3.4	1.5	2.2	0.72
Patella	0.5	0.8	0.6	0.7	0.52
Tibia	0.9	2.7	1.2	2.1	0.39
Metatarsus	0.8	2.3	0.8	1.1	—
Tarsus	1.1	2.3	1.1	1.3	0.30

MEASUREMENTS: All measurements in millimeters:

Male from Del Norte Coast Redwoods State Park: Total length, 3.4. Scute length, 2.7. Breadth of abdomen, 1.7. Appendages as in table 6.

Female from Miranda, California: Total length, 4.2. Scute length, 3.5. Abdomen 2.6 wide. Appendages as in table 7.

VARIATION: Variations in meristic characters are summarized in table 8.

Variation in color pattern probably depends on age, older animals being darker, with the light bands less clearly defined. The color pattern is often obscured by the animals' coats of dirt. With regard to the scute keels, about half the animals studied showed some smaller cells interspersed between the larger ones of

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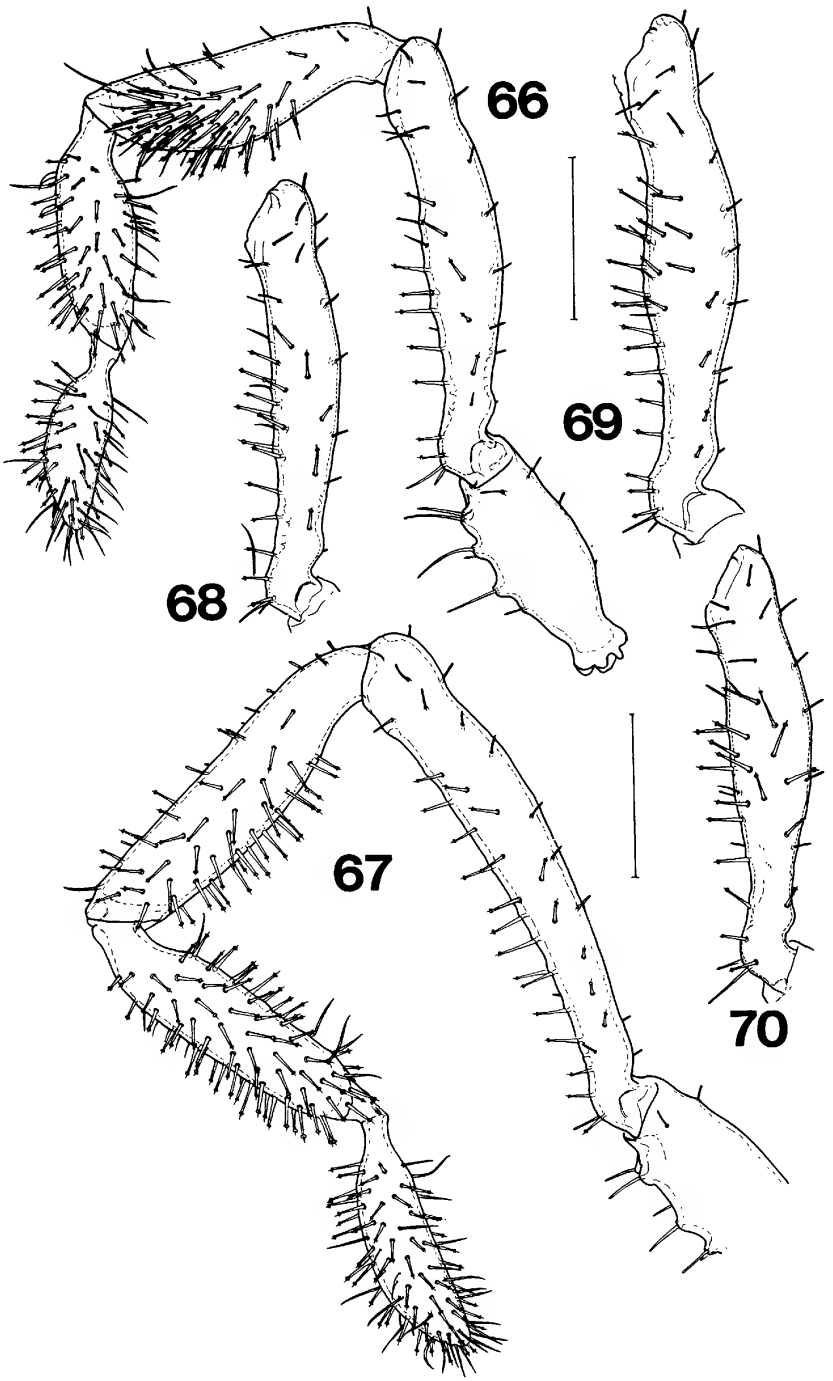
FIGS. 49–65. *Ortholasma pictipes*. 49. Male from Del Norte Coast Redwoods, dorsal view. 50. Female from Miranda, dorsal view. 51–60. Hoods. 51. Female from Miranda, lateral view. 52. Male from Maynard, dorsal view. 53. Male from Little River, dorsal view. 54. Male from Pepperwood, dorsal view. 55. Male from Del Norte Coast Redwoods, lateral view. 56. Female from Kyuquot, dorsal view. 57. Female from Friday Harbor, dorsal view. 58. Female paratype, dorsal view. 59. Male from Charleston, dorsal view. 60. Male from Miranda, dorsal view. 61–63. Male right chelicera. 61. Lateral view. 62. Mesal view. 63. Dorsal view, anterior to the right. 64. Microsculpture of second leg femur. 65. Seminal receptacles. Scale line = 2.0 mm. for figures 49, 50; 1.0 mm. for figures 51–60; 0.35 mm. for figures 61–63; 0.18 mm. for figure 65; 0.15 mm. for figure 64.



FIGS. 66–70. *Ortholasma pictipes,* pedipalps. 66. Right palpus of male from Charleston, mesal view. 67. Right palpus of female from Rockport, mesal view. 68. Right palpal femur of male from Westport, mesal view. 69. Same, but of male from Pepperwood. 70. Same, but of another male from Charleston. Scale lines = 0.25 mm. for all figures.

TABLE 7
Leg and Palpal Segments of Female *Ortholasma pictipes* from Miranda
(Measurements in millimeters.)

	Legs				
Segment	1	2	3	4	Palpus
Trochanter	—	—	—	—	—
Femur	1.5	3.9	1.8	2.6	0.90
Patella	0.6	1.0	0.7	0.9	0.63
Tibia	1.0	3.1	1.4	2.5	0.51
Metatarsus	0.9	2.5	0.9	1.2	—
Tarsus	1.0	2.4	1.1	1.3	0.40

the first four dorsal areas and median on the abdomen. Otherwise, the degree of variation is about the same as expressed in *rugosum*. In a few specimens, the single transverse keel on the frontal wall of the carapace had oblique connecting keels to the eye keels. There appears to be much less variation in the form of the hood (figs. 51–60) than in *O. rugosum*; despite some size differences, the proportions are relatively constant. Males mostly have six fenestrations on each side above the eyes, sometimes seven, rarely five or eight (the Del Norte male is unusual in this regard). In females, six and seven fenestrations occur commonly, five or eight are rare. One male and one female each had slightly bifid tips on the large lateral spines; one female had a third spine on the right side. Variation in the pseudoarticulations of metatarsus 2 is somewhat broader in females, but in both sexes the most common number seems to be nine; males have a tendency to higher numbers (10 males of 31 examined had 10 or 11 pseudoarticulations). Males also tend toward the higher numbers of tarsomeres on all legs. For the first leg, the most common number for males was nine, for females seven; for the second leg males commonly had 15 or 16, females 11 or 12; for the third leg males commonly had nine, females eight; and for the fourth leg males and females both had nine as the most usual number. Again, the numbers ranged higher in males and lower in females.

Because of a lack of sizable samples from any one locality, it is difficult to assess geographic variation in this widespread species.

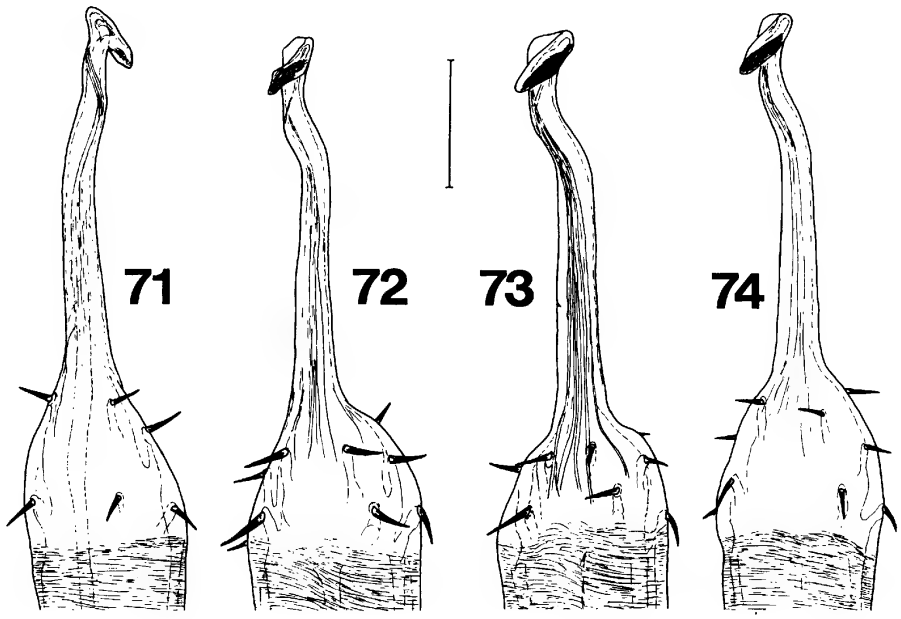
TABLE 8
Variation in Meristic Characters in *Ortholasma pictipes*
(Measurements in millimeters.)

Measurement	Range	Mean and S.D.
Total body length:		
Males (n = 17)	3.0–3.8	3.39 ± 0.21
Females (n = 14)	3.6–4.5	4.06 ± 0.26
Scute length:		
Males	2.4–3.0	2.73 ± 0.18
Females	3.0–3.7	3.36 ± 0.22
Breadth of abdomen:		
Males	1.7–2.1	1.91 ± 0.13
Females	2.1–2.6	2.41 ± 0.14
Length of femur 2:		
Males	3.1–4.0	3.44 ± 0.28
Females	2.8–3.9	3.43 ± 0.36
Penis length (n = 4)	1.66–1.98	1.82
Total length/length less hood:		
Males	1.18–1.28	1.24
Females	1.17–1.29	1.21
Total length/breadth of abdomen:		
Males	1.57–2.00	1.78
Females	1.56–1.83	1.69
Total length/length of femur 2:		
Males	0.78–1.13	0.99
Females	1.03–1.41	1.18

Our study reveals no clearly marked trends, except for a slight tendency to larger size on the part of animals from the northerly sections of the range.

Juvenile Stages: We have seen five juveniles of three distinct instars, probably one subadult, three presubadult, and one much smaller stage. Of particular interest is the development of the hood; as it grows relatively longer in subsequent instars, it becomes more depressed. This may be a derived characteristic.

Relationships: *Ortholasma pictipes* is most closely related to *O. rugosum*. The color pattern, the depressed, smaller, broader hood and the stouter palpi seem to be correlated, because when these characteristics are expressed to some degree in *rugosum* as well as in *pictipes* (where they are typical of the

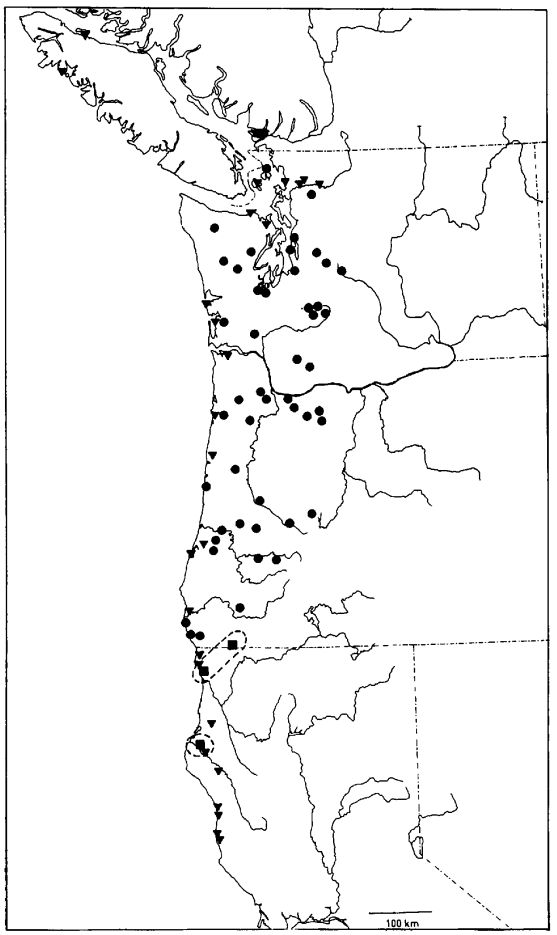


FIGS. 71–74. *Ortholasma pictipes,* penis tips. 71. Friday Harbor, dorsal view. 72. Charleston, ventral view. 73. Pepperwood, ventral view. 74. Westport, ventral view.

species), they are found together. Some functional significance may be attached to the short hoods and stouter palp, but we do not know what it may be.

DISTRIBUTION: See maps 1 and 2. The range of *Ortholasma pictipes* is relatively extensive, consisting of a long strip on the Pacific coast from southern British Columbia (more northerly records are possible, see distributions of *Dendrolasma mirabilis*) to Mendocino County in northern California. Thus *O. pictipes* seems to be a typical member of the Vancouveran fauna (Van Dyke, 1919; Linsley, 1958), or an Oregonian range type of Munz and Keck (1959). Compared with *Dendrolasma mirabilis,* which has a similar north-south distribution, *O. pictipes* is restricted to a narrow strip along the coast. This observation leads us to discount all the more the Mt. Wilson record published by Banks (1911), since although members of the Vancouveran fauna sometimes do occur on southern California mountaintops, they belong to the Sierran subfauna (Van Dyke, 1919), not the Pacific Maritime group. The subalpine coniferous forests of southern California mountains are more arid than those of the Pacific Northwest.

RECORDS: *CANADA:* BRITISH COLUMBIA: Alert Bay, June 21, 1936 (C. Crosby), ♂ (AMNH); Kyuquot, Walters Cove, June 10–15 (S. Neave), ♀ (AMNH); Vancouver, June 10, 1963 (E. Thorne), 2♂♂, 3♀♀ (BCPM). *UNITED STATES:* WASHINGTON: *San Juan Co.:* Friday Harbor, June–July 1928 (Shackleford), ♂, ♀ (AMNH). *Jefferson Co.:* 0.5 mi. NE Maynard, June 23, 1966 (V. Lee), ♂ (CAS). *Callam Co.:* Dungeness, Sept. 20, 1931 (T. Kincaid), juv. (BMM). *Pacific Co.:* Bay Center, Aug. 31, 1931 (T. Kincaid), ♂ (BMM). *Whatcom Co.:* 7.1 mi. S Bellingham, Dec. 14, 1974 (R. Crawford), ♀ (BMM). *Grays Harbor Co.:* Westport, Nov. 11, 1937 (W. Baker), ♀, 2 juvs. (BMM). *Skagit Co.:* 3.2 and 4.2 mi. NW Sedro Woolley, Sept. 8, 1977 (R. Crawford, C. Stoner), 2♂♂, ♀, 3 juvs. (BMM); 0.1 mi. E Lyman, Sept. 28, 1975 (R. Crawford), 10 juvs. (BMM). OREGON: *Coos Co.:* Charleston, July and Sept. 1947 (I. Newell), ♂, ♀, juvs. (AMNH); Charleston, woods behind Marine Biological Institute, Apr. 29, 1967 (E. Benedict), ♂ (WAS); 8 mi. E, 2 mi. S Allegany,



MAP 2. Northern California, Oregon, Washington, and southern British Columbia, showing distribution of *Orthola sma pictipes* (triangles), *Dendrolasma mirabile* (dots), and *D. dentipalpe* (squares enclosed in dashed lines). Not shown is the far northern record for *D. mirabile* from Metlakatla, British Columbia, just south of the Alaskan border, near Prince Rupert.

Weyerhauser Co. Millicoma Tree Farm, Company Road 5000, Nov. 20, 1971 (E. Benedict), ♀ (WAS). *Curry Co.:* 4 mi. S Pistol River on US 101, Feb. 12, 1972, 3♂♂, ♀ (WAS); 7 mi. N, 3 mi. W Brookings, Feb. 12, 1972 (E. Benedict), ♂ (WAS). *Clatsop Co.:* 3 mi. SE Olney on Oregon 202, Nov. 27, 1971 (E. Benedict), 3♀♀ (WAS); 3 mi. N, 11 mi. W Elsie, Mar. 15, 1972, ♀ (WAS). *Tillamook Co.:* Sand Beach Campground, Suislaw National Forest, 2 mi. W Sandlake, Nov. 4, 1972 (E. Benedict), 2♂♂ (WAS). *Lincoln Co.:* 0.6 mi. NW Elk City on Yaquina River, Dec. 10, 1971 (E. Benedict), 3 juvs. (WAS). CALIFORNIA: *Del Norte Co.:* Ft. Dick, Dec. 12, 1966 (C. O'Brien), ♂ (CAS); 4 mi. NW Del Norte Coast Redwoods State Park, June 25, 1966 (T. Briggs, K. Hom), ♂, 2♀♀ (CAS). *Humboldt Co.:* 18 mi. W Willow Creek, Aug. 21, 1959 (W. Gertsch, V. Roth), ♀ (AMNH); 2 mi. N Pepperwood, Jan. 28, 1967 (T. Briggs, V. Lee), 3♂♂ (CAS); 2.7 mi. N Pepperwood, June 25, 1966 (T. Briggs), 2♀♀ (CAS); Humboldt Redwoods State Park, near Miranda, Sept. 30, 1963 (W. Gertsch), ♀ (AMNH); Miranda, June 4, 1936 (no collector's name), ♂, ♀ (AMNH). *Mendocino Co.:* Rockport, July 19, 1962 (V. Roth), ♀ (AMNH); 1.5 mi. S Westport, July 19, 1962 (V. Roth), ♂, ♀ (AMNH); Mendocino, Aug. 18, 1957 (J. Helfer), ♂ (AMNH).

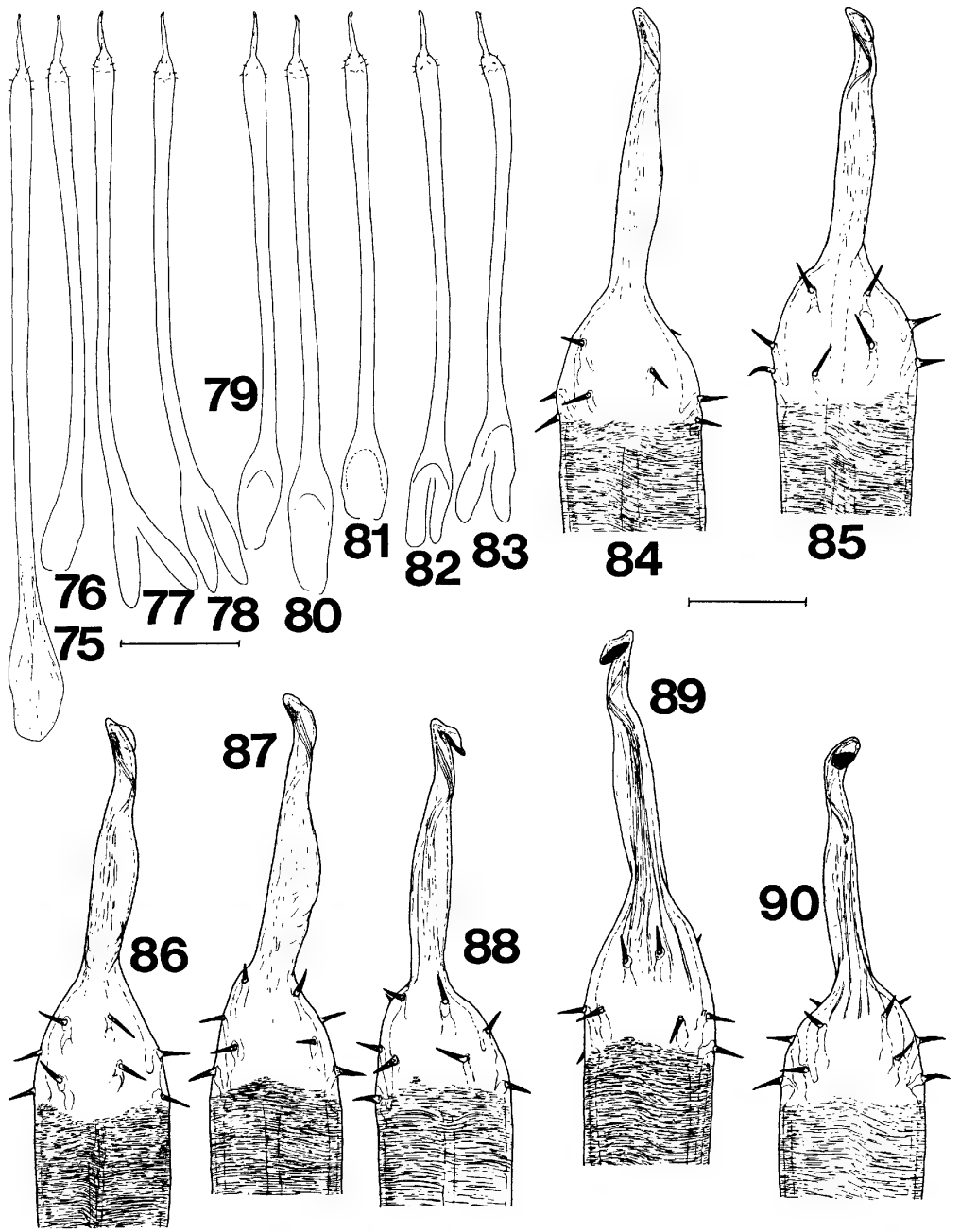
ECOLOGY: Notes on collection labels suggest that the species is most commonly found in moist coniferous forests composed of Coast Redwood, Douglas Fir, and Sitka Spruce. Bragg and Leech (1972) have collected the species all through the year near Vancouver, from pitfall traps and litter. The overwintering of juveniles appears likely; adults are found mostly from March to October.

Ortholasma levipes, new species

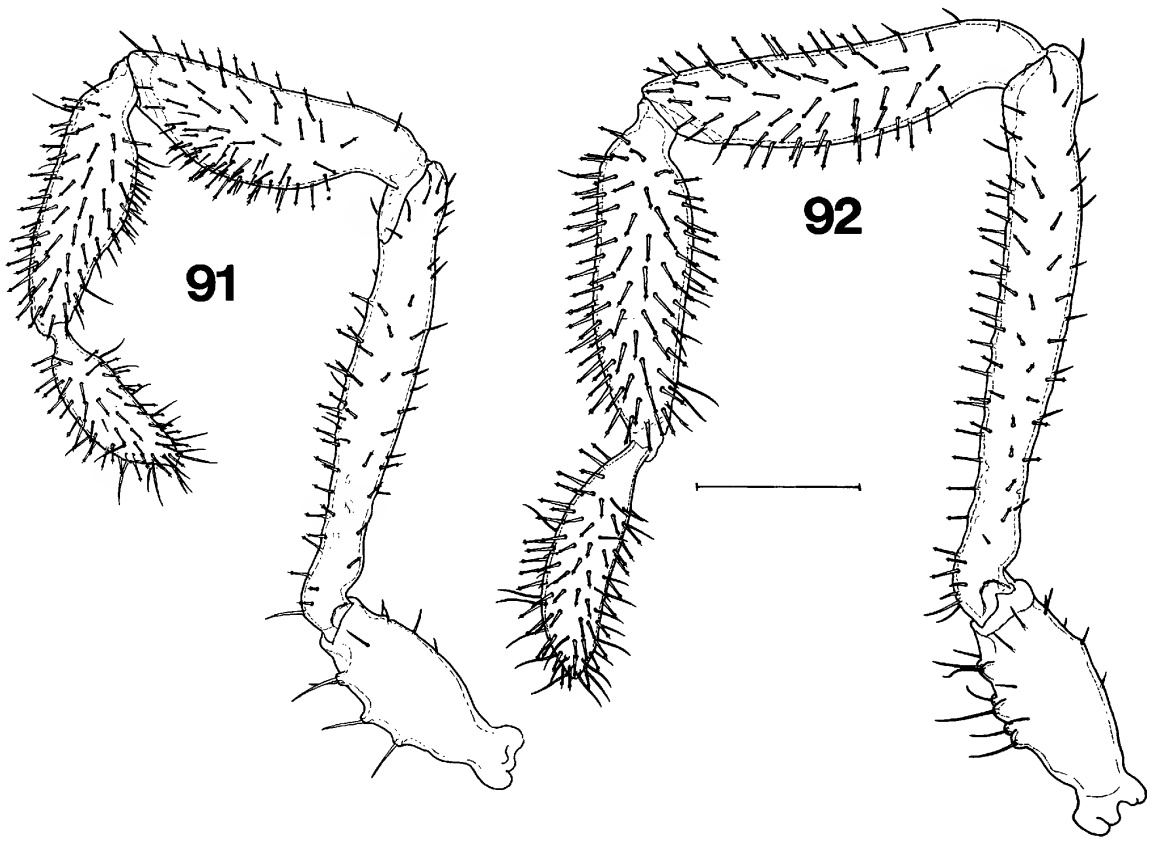
Figures 75–106; Map 1

Ortholasma rugosa Banks, 1894a, p. 12 (in part, see below); 1904, p. 63 (in part, specimens from Claremont?); 1911, p. 418 (in part: "common in Southern California, Claremont," citations from other localities are probably other species). Roewer, 1923, p. 648 (in part, cites localities of Banks).

TYPES: Male holotype from Navajo Camp, La Panza, Los Padres National Forest, San Luis Obispo Co., California (CAS). In addition, the specimens listed under "Distribution" below have been designated as paratypes and are deposited in the given museums (CAS, AMNH, MCZ, Šilhavý collection). A female paratype in the MCZ was originally a part of the "type series" of *O. rugosum,* and Banks evidently confused this species with both *rugosum* and *setulipes.* In the absence of specimens we can only guess at the assignment of old published records.



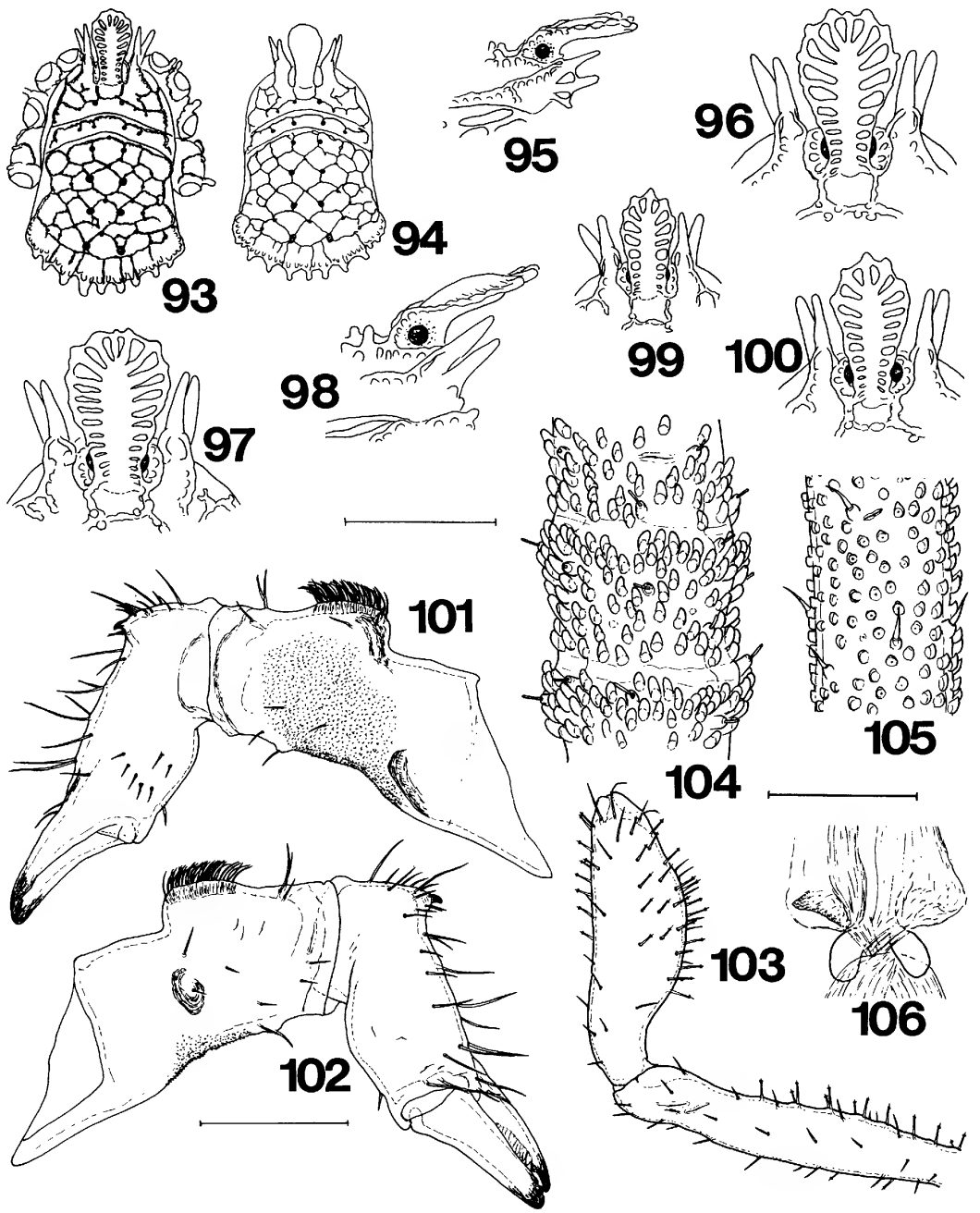
FIGS. 75–90. *Ortholasma levipes*, penes. 75–83. Dorsal views of whole organ. 75. Reservoir Canyon, showing muscles. 76. Sepulveda Canyon. 77. Lake Kaweah office. 78. Napa. 79. Sebastopol. 80. Wool Hollow Cave. 81. Woodlake–Lemoncove Road. 82. Briceburg. 83. Santa Cruz Island. 84–90. Penis tips. 84. Sebastopol, dorsal. 85. Briceburg, dorsal. 86. Wool Hollow Cave, dorsal. 87. Sepulveda Canyon, dorsal. 88. Santa Cruz Island, dorsal. 89. Napa, ventral. 90. Woodlake–Lemoncove Road, ventral. Scale lines = 0.4 mm. for figures 75–83; 0.1 mm. for figures 84–90.



FIGS. 91, 92. *Ortholasma levipes,* mesal views of right pedipalps. 91. Male. 92. Female. Scale line = 0.25 mm.

DIAGNOSIS: A species of *Ortholasma, sensu stricto* differing from *O. pictipes* in having a uniform brown color pattern, from *O. rugosum* in having pseudoarticulations in the leg femora, and from *O. setulipes* in having the microsculpture of the legs consisting of broad, blunt denticles producing a granulated, rather than finely pubescent, appearance.

DESCRIPTION: Male holotype (fig. 93): Dorsal side of body uniformly light to medium brown, abdomen with very slight median lighter band; carapace laterally and caudally of eye tubercle darker brown. Tubercles and keels darker against light cuticle surrounding their bases, distal half of hood and lateral spines lighter brown to whitish. Ventral side and legs more or less uniformly brown, but femora slightly paler near basal constriction. Body form as usual. Hood (figs. 96, 99, 100) broad, spoon-shaped, eyes not visible from above (only lenses), rim keels with one apical and 11 lateral tubercles on each side, seven or eight fenestrations on each side above eyes. Hood in lateral views (fig. 95) slightly elevated above carapace, median process inserting dorsorostrally on eye mound, bent rostrally. Lateral carapace spines relatively slender, conical. Front wall of carapace with two transverse keels, the upper rooflike, with two connecting keels. Carapace with typical keel pattern, star-shaped figure on each side formed by keels jutting inward from lateral margin. Scute areas 1–4 with paired spines or knobs, thoracic segments each with one



FIGS. 93–106. *Ortholasma levipes*. 93. Male holotype, dorsal view. 94. Small male from Sepulveda Canyon, dorsal view, detail omitted. 95–100. Hoods, various views. 95. Male from Sepulveda Canyon, lateral. 96. Male from Reservoir Canyon, dorsal. 97. Female from Atascadero, dorsal. 98. Same, lateral. 99. Male from Woodlake–Lemoncove Road, dorsal. 100. Male from Claremont, dorsal. 101,102. Right chelicera of male. 101. Mesal view. 102. Lateral view. 103. Distal part of femur and tibia of right male palp, lateral view. 104. Microsculpture of adult second leg femur. 105. Same, subadult second leg femur. 106. Seminal receptacles. Scale lines = 1.0 mm. for figures 93, 94; 1.0 mm. for figures 95–100; 0.35 mm. for figures 101, 102; 0.25 mm. for figure 103; 0.15 mm. for figures 104, 105; 0.18 mm. for figure 106.

pair, largest pair on area 4. Scute keel pattern typical. Free tergites with low rows of tubercles, venter with more or less isolated tubercles in rows.

Chelicerae (figs. 101, 102) similar to those of *O. rugosum,* basal article with small, oval, densely hairy area often with coagulated glandular secretions. Palpi as in figures 91, 103; femora slender, about 7.1 times as long as thick, ventral side slightly convex, with only slight development of glandular tissue; patellae with strongly convex ventral contour, 3.1 times as long as broad, with pointed hairs between clavate setae. Tibiae about 3.5 times as long as thick, glandular area evident ventrally near base. Tarsus as usual.

LEGS: Trochanters with elongated tubercles. Femora stout, first and third slightly spindle-shaped, thickened in middle, five or six times as long as thick; fourth femora somewhat less robust, about eight times as long as thick, second femora smooth in contour, cylindrical, about 11 times as long as thick. Pseudoarticulations of leg segments often unclear, in this specimen first femora with 3/3(4?) in basal half as constrictions; second femora 8/10 dispersed along length; third with 2/4 in basal half; fourth with 5/5 in basal two-thirds, quite indistinct. Tibiae with three or four pseudoarticulations. Metatarsi 2 with 6/6 pseudoarticulations. Tarsal numbers: 7(5+2)/8(6+2)–12(10+2)/12–8(4+2+2)/7(3+2+2)–8/9(5+2+2). Leg microsculpture (fig. 104) consisting of blunt, conical denticles with rounded tips, only slightly compressed, evenly dispersed, absent from pseudoarticulatory regions, becoming slightly more acute and appressed distally, especially on tibiae.

GENITAL MORPHOLOGY: Penis (figs. 75–90) similar to that of *O. rugosum,* with slight differences in proportions; glans more elongate, stylus relatively shorter, only about twice the length of glans proper.

Female from Atascadero, California: Similar to male with the usual differences in size and proportions. Genital operculum broad, apical lip with transverse concavity. Chelicerae as usual, without modifications found in male. Palpi (fig. 92) more slender, lacking glands, femora 7.8, tibiae 4.0, patellae 3.4 times as long as thick. Legs: femora with 3/3, 9/7, 3?/3, 4/5 pseudoarticulations, tibiae 2 with three or four pseudoarticulations, metatarsi 2 with seven pseudoarticulations on left side, right side missing. Tarsal numbers; 8/9–10/- –10/10// –10/10. Genital morphology: ovipositor as usual, seminal receptacles (fig. 106) round sac on each side.

TABLE 9
Leg and Palpal Segments of Male Holotype of *Ortholasma levipes*
(Measurements in millimeters.)

Segment	Legs				Palpus
	1	2	3	4	
Trochanter	—	—	—	—	0.35
Femora	1.4	2.7	1.6	2.4	0.79
Patella	0.5	0.7	0.5	0.7	0.51
Tibia	1.1	2.2	1.3	2.2	0.47
Metatarsus	0.8	1.8	0.8	1.2	—
Tarsus	1.0	1.9	0.9	1.1	0.30

MEASUREMENTS: All measurements are in millimeters:

MALE HOLOTYPE: Total length, 3.7. Length without hood, 3.1. Breadth of abdomen, 2.1. Appendages as in table 9.

Female from Atascadero: Total length, 4.2. Length without hood, 3.5. Breadth of abdomen, 2.6. Appendages as in table 10.

VARIATION: For comparative purposes, we give below measurements for Sierran foothill specimens similar to those for the Coast Range specimens described above.

Male from Woodlake–Lemoncove Road: Total length, 3.1. Length without hood, 2.6. Breadth of abdomen, 1.9. Legs as in table 11.

Female from Woodlake–Lemoncove Road: Total length, 3.5. Length without hood, 2.9. Breadth of abdomen, 2.1. Appendages as in table 12.

Variation in meristic characters is summarized in table 13. Males and females may have from one to four pseudoarticulations in the first femora, but most specimens have two. For the second femora, males range from five to 11, females from six to 11, most have seven or eight; for third femora males range from one to five, females from one to three, most have two; for the fourth femora males range from two to six, females from two to five, most have three. Pseudoarticulations may be absent from the second tibiae, or there may be as many as eight; most specimens

TABLE 10
Leg and Palpal Segments of Female *Ortholasma levipes* from Atascadero
(Measurements in millimeters.)

	Legs				
Segment	1	2	3	4	Palpus
Femora	1.4	3.0	1.6	2.1	0.94
Patella	0.6	0.8	0.6	0.8	0.65
Tibia	1.0	2.4	1.2	2.0	0.54
Metatarsus	0.9	2.2	0.9	1.3	—
Tarsus	1.1	1.9	1.1	1.3	0.40

TABLE 12
Leg and Palpal Segments of Female *Ortholasma levipes* from Woodlake-Lemoncove Road
(Measurements in millimeters.)

	Legs			
Segment	1	2	3	4
Femora	1.0	2.0	1.1	1.7
Patella	0.4	0.6	0.5	0.6
Tibia	0.7	1.5	0.8	1.5
Metatarsus	0.7	1.7	0.7	1.1
Tarsus	0.8	1.5	0.8	1.0

have three or four. In the second metatarsi, the range is two to nine, with three the most common number. The most common tarsomere numbers were six, eight, eight, and eight, respectively. There was considerable variation in the number of articles in the second tarsi of the males, the range being from seven to 15, but more than half of the specimens examined had eight or nine.

Variation in body form is concentrated in the hood (figs. 95–100), two types occurring as extremes with a smooth intergradation between them. Some animals had large, spoon-shaped hoods like those of *rugosum* specimens, with the maximum width about 2.2 times the width above the eyes. Such hoods occur most commonly in large specimens. Smaller animals tend to have narrower, parallel-sided hoods only about 1.75 times as wide at their widest point as above the eyes. Some of the narrow hoods may have one less fenestration on each side than the lowest numbers in the broad hoods. Variation in the keels and spines of the scute is about as described for the other species; it appears to be of little significance. Small sample size, however, makes quantification of our impressions impossible now.

We discern two or possibly three populations geographically, which might, on more thorough examination, prove to be recogniz-

TABLE 11
Leg and Palpal Segments of Male *Ortholasma levipes* from Woodlake-Lemoncove Road
(Measurements in millimeters.)

	Legs			
Segment	1	2	3	4
Femora	1.0	1.9	1.1	1.6
Patella	0.4	0.6	0.5	0.6
Tibia	0.7	1.5	0.8	1.4
Metatarsus	0.7	1.7	0.7	1.0
Tarsus	0.8	1.5	0.8	0.9

TABLE 13
Variation in Meristic Characters in *Ortholasma levipes*
(Measurements in millimeters.)

Measurement	Range	Mean and S.D.
Total body length:		
Males (n = 18)	3.0–3.8	3.23 ± 0.27
Females (n = 9)	3.2–4.2	3.54 ± 0.29
Length less hood:		
Males	2.4–3.1	2.68 ± 0.22
Females	2.6–3.5	2.99 ± 0.24
Breadth of abdomen:		
Males	1.6–2.1	1.80 ± 0.17
Females	1.9–2.6	2.08 ± 0.21
Length of femur 2:		
Males	1.8–3.2	2.26 ± 0.43
Females	1.9–3.0	2.14 ± 0.34
Total length/length less hood:		
Males	1.15–1.25	1.20
Females	1.14–1.23	1.18
Total length/breadth of abdomen:		
Males	1.65–1.94	1.79
Females	1.57–1.90	1.79
Total length/length of femur 2:		
Males	1.14–1.74	1.43
Females	1.40–1.89	1.65

able as subspecies. Large, relatively long-legged specimens with higher tarsal numbers and broad hoods come from the southwestern part of the species range. Those from the more northerly Coast Ranges are somewhat smaller. Specimens from the Sierra Nevada foothills are, on the other hand, smaller with shorter legs and narrow hoods. A possible third isolate is represented by a single male from Santa Cruz Island; this specimen is small, short-legged, with slender palpi. The hood evidently has been damaged in some way, but looks like the narrow type. This specimen also has strikingly well-developed dorsal spines on the scute.

Several authors (see "biogeography") have pointed out the presence among soil invertebrates and other moisture-dependent elements of the fauna that a disjunction often occurs between southerly Coast Range populations and those of the Sierra foothills. In a few cases it has seemed proper to recognize two species in a given genus, or to provide subspecific names for the two populations. We do not think either move to be appropriate here, at least not until more material becomes available for analysis. The Sierra foothills specimens may only be part of a ring surrounding the Central Valley, the desiccation of which in the present interglacial seems to have caused the disjunction.

JUVENILE STAGES: We found four subadults clearly associated with adults. They differ from the adults in much the same way as we have described for other species.

RELATIONSHIPS: *Ortholasma levipes* is most closely related to *O. setulipes.* See the discussion under that species.

DISTRIBUTION: See map 1. This species has been collected from widely dispersed localities in the northern and southern Coast Ranges and the transverse ranges in Sonoma, Napa, Monterey, San Luis Obispo, and Los Angeles counties, as well as from one of the Channel Islands, Santa Cruz, which seems geologically related to the transverse ranges. A second chain of localities follows the foothills of the western slopes of the Sierra Nevada in Eldorado, Calaveras, Mariposa, Tuolumne, and Tulare counties. We expect that further collecting will result in the discovery of many additional localities in both regions and possibly some records linking the two areas. Like *O. setulipes,* this species is "Californian" in the sense of Linsley (1958), but evidently without the historical implications he attaches to the xerophyll flora, namely its relationships to South America.

RECORDS: CALIFORNIA: *San Luis Obispo Co.:* Navajo Camp, La Panza, Los Padres National Forest, May 25, 1965 (T. Briggs), ♂ (CAS); 3 mi. SW Atascadero, Feb. 25, 1967 (T. Briggs, V. Lee), ♀ (CAS); Reservoir Canyon, near San Luis Obispo, July 15, 1959 (W. Gertsch, V. Roth), 2♂♂ (AMNH). *Santa Cruz Island:* 0.5 mi. SW University of California Field Station, Dec. 20, 1967 (K. Hom), ♂ (CAS). *Los Angeles Co.:* Sepulveda Canyon, Santa Monica Mts., March 1956 (R. Schick), ♂ (AMNH); Claremont, Nov. 1910 (no collector's name), ♂ (AMNH). *Monterey Co.:* Del Monte Forest, 1.5 mi. S Pacific Grove, Oct. 8, 1945 (A. Archer), ♀ (AMNH); False Point Sur, Mar. 20, 1966 (T. Briggs), juv. (CAS). *Napa Co.:* Napa, Feb. 24, 1959 (R. Schuster), ♂, ♀ (AMNH). *Sonoma Co.:* Sebastopol (no further data), 3♂♂, juv. (USNM). *Eldorado Co.:* Nashville, Apr. 25, 1958 (L. Smith, R. Schuster), ♂ (AMNH). *Calaveras Co.:* Wool Hollow Cove Cave, near Vallecito, June 12, 1966 (T. Briggs), ♂ (CAS). *Mariposa Co.:* Briceburg, Nov. 12, 1966 (T. Briggs), ♂ (CAS). *Tuolumne Co.:* 2000 ft. above Camtaro and Stanislaus Road, near Vallecito, Apr. 26, 1966 (T. Briggs, V. Lee), ♀ (CAS). *Tulare Co.:* 0.9 mi. N junction Woodlake and Lemoncove roads, Apr. 8, 1966 (K. Hom, V. Lee, T. Briggs), 4♂♂, 4♀♀, juvs. (CAS); Lake Kaweah Office, May 14, 1966 (T. Briggs), 2♂♂, juvs. (CAS).

ECOLOGY: As usual we must rely on fragmentary data from collection labels. The type locality is in a "xeric forest" at 750–800 m. elevation; at Atascadero specimens were found in an "oak forest," and in Napa Co. in "orchards." Generally the range coincides with Mediterranean-type chaparral and oak woodland. In the northern part of the species range, the mosaic nature of the habitat makes conclusions impossible without careful collecting, but the localities seem to be outside the humid coastal zone. In the southern part of the range, canyons are mentioned several times on collection labels.

ETYMOLOGY: The specific epithet is a Latin adjective referring to the lighter armament of

the legs of this species when compared to the foregoing.

Ortholasma setulipes, new species
Figures 5, 11, 107–131; Map 1

Ortholasma rugosa, Banks, 1894a, p. 12 (in part); 1904, p. 363 (in part, probably specimens from Claremont); 1911, p. 418 (in part, "southern California"). Hilton, 1919, p. 41. Roewer, 1923, p. 648 (in part; cites Banks's localities).

TYPES: Male holotype from Borrego Palm Canyon, Anza-Borrego Desert State Park, San Diego Co., California (CAS). In addition, the specimens listed under "Distribution" below have been designated as paratypes and are deposited in the given museums (MCZ, AMNH, Šilhavý Collection). As we have noted under *O. rugosum,* most of the old records are hard to evaluate because the present species and the following one were both confused with *rugosum.* We have tried to make assignments of the old records for which we did not see specimens on geographical and ecological grounds.

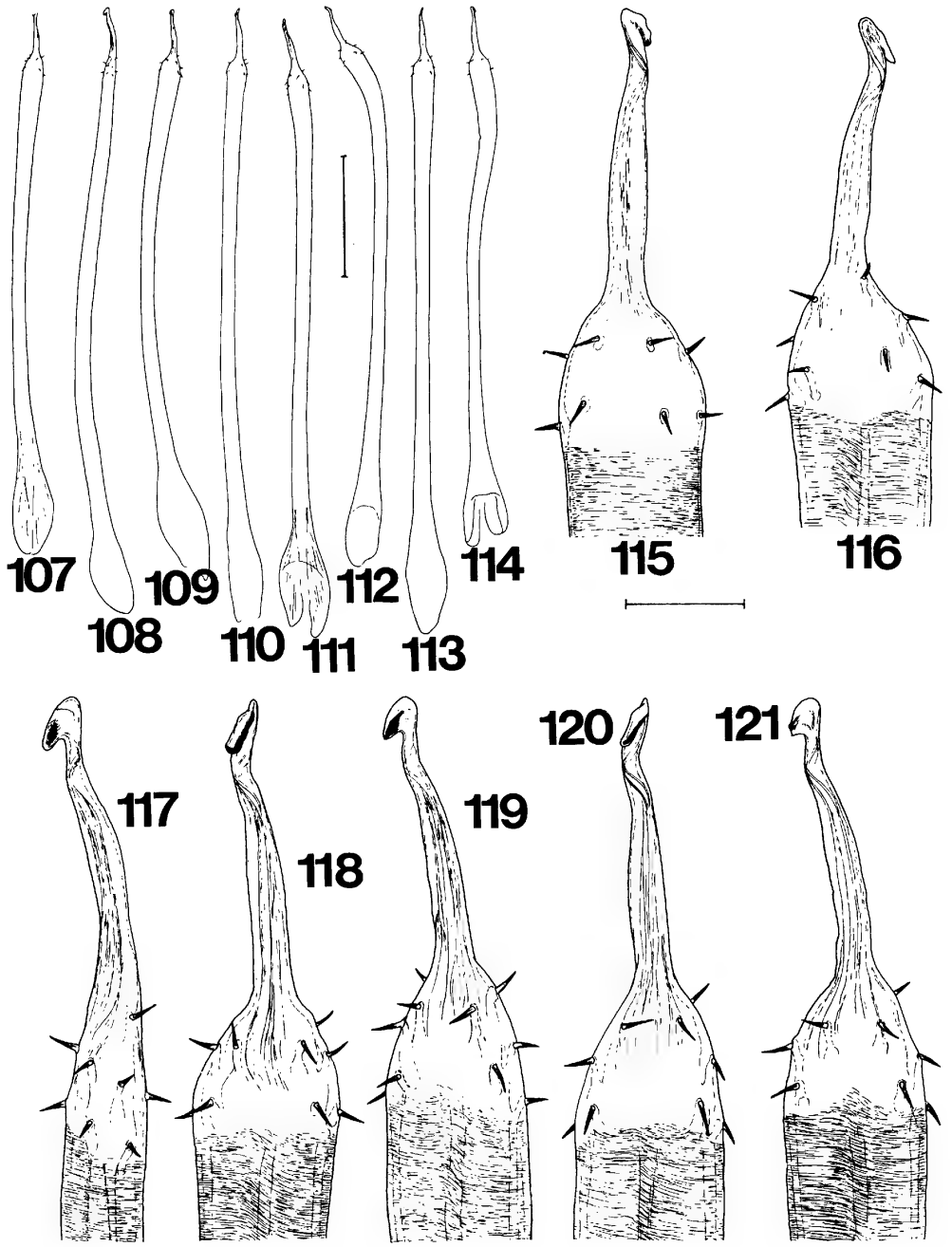
DIAGNOSIS: A Californian species of *Ortholasma, sensu stricto* differing from *rugosum* and *pictipes* in having pseudoarticulations in the second leg femora, and also from the latter in the uniform color pattern. As in *levipes, setulipes* lacks the characteristic clumped denticles which give the two previously described species the appearance of having "bumpy" legs. *Ortholasma setulipes* differs from *levipes* consistently only in the leg microsculpture, which in the present species gives the impression of an even, finely hairy surface, as opposed to the denticulate appearance of *levipes.*

DESCRIPTION: Male holotype: Body uniformly light to medium brown, eye tubercle, caudal margin of carapace and scute, and muscle insertions darker brown; keels slightly darker against light cuticle. Spines and processes pale, whitish, likewise distal half of hood and lateral carapace spines. Leg femora light brown, denticles somewhat darker, giving appearance of dark pubescence. Patellae and tibiae like femora; metatarsi and tarsi lighter brown.

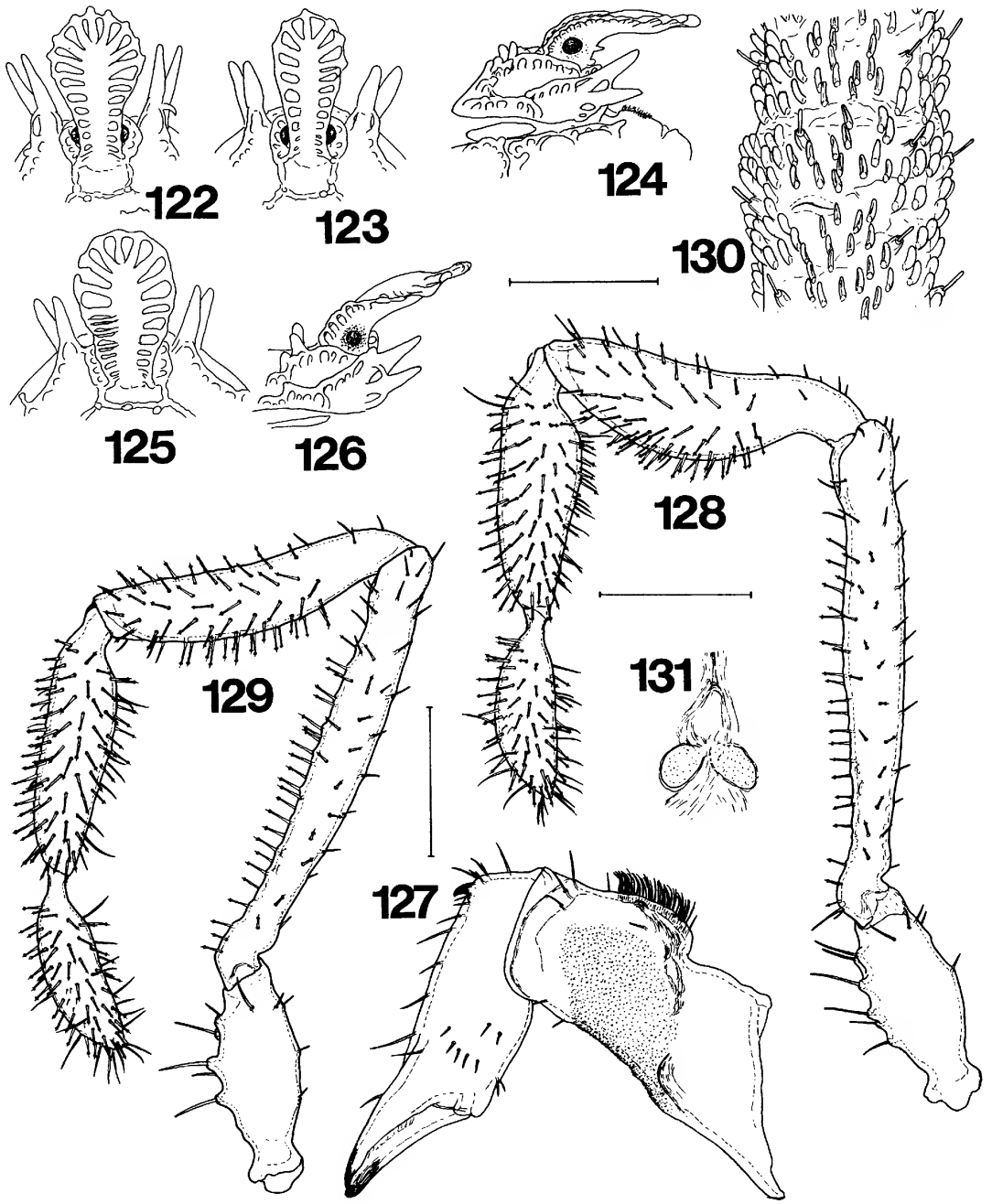
Body form as usual. Hood (figs. 122–124) well elevated above carapace, median process with horizontal distal part above eye level, inserted dorsorostrally on eye tubercle. In dorsal view hood spoon-shaped, rim keels continue as supraocular keels, eyes not visible from above (only the lenses). Maximum width of hood about two times breadth above eyes. Ten to 13 lateral rim processes above eyes, five to seven fenestrations on each side above eyes. Lateral carapace spines blunt, conical, bridged to circumocular keel by tubercle without elongated head. Anterior wall of carapace below hood with two transverse keels, the upper rooflike, sometimes broken in the middle; two connecting keels present. Carapace with usual keel pattern; thoracic segments 1 and 2 with four spines in caudal keels, median pairs higher. Abdominal scute with typical keel pattern; areas one to four with paired spines and with median smaller spines at keel intersections; lateral portions with smaller, dispersed spines. Shape of spine heads blunt, conical, surfaces of spines mostly smooth, but larger ones slightly granulated. Free tergites and sternites with rows of tubercles more or less reduced in the median parts.

Chelicerae (fig. 127) like those of *O. levipes,* dorsal gland area relatively small. Palpi (fig. 128): femora slender, about eight times as long as thick, no evidence of dense glandular tissue; patellae with slight concave dorsal curvature, pronounced convex curvature ventrally, about 3.4 times as long as thick, ventromedially with short, pointed hairs among the clavate ones, distinct glandular area with coagulated secretions in this region; tibiae stalked, 3.2 times as long as thick, densely set with clavate hairs; tarsi as usual.

LEGS: Trochanters with rounded tubercles. Femora 1 and 3 stout, greatest width occurring in apical third; femur 4 less robust, femur 2 cylindrical, with 5/3 pseudoarticulations at midlength. Femoral contours smooth. Microsculpture (fig. 130) of blunt setae on low papillae, giving appearance of short, closely appressed hairiness; these more acute distally, especially on tibiae. Patellae similar in microsculpture to femora. Tibiae 2 with single indistinct pseudoarticulation in basal third. Metatarsi 2 with pseudoarticulations 5/6. Tarsal numbers: 11(9+2)/12(10+2)–



FIGS. 107–121. *Ortholasma setulipes,* penes. 107–114. Views of whole organs. 107–109. Three different males from Claremont. 110. Reservoir Canyon. 111–113. Three additional males from Claremont. 114. Borrego Palm Canyon. 115–121. Penis tips. 115. Borrego Palm Canyon, dorsal. 116. Claremont, dorsal. 117. Another Claremont male, lateral. 118. Reservoir Canyon, ventral. 119–121. Three different specimens from Claremont, all ventral views. Scale lines = 0.4 mm. for figures 107–114; 0.1 mm. for figures 115–121.



FIGS. 122–131. *Ortholasma setulipes*. 122–126. Hoods. 122. Male from Reservoir Canyon, dorsal. 123. Male from Borrego Palm Canyon, dorsal. 124. Male holotype, lateral. 125. Female from Barton Flats, dorsal. 126. Same, lateral. 127. Male right chelicera, mesal view. 128. Male right pedipalp, mesal view. 129. Female right pedipalp, mesal view. 130. Microsculpture of femur of second leg. 131. Seminal receptacles. Scale lines = 1.0 mm. for figures 122–125; 0.35 mm. for figure 127; 0.25 mm. for figures 128, 129; 0.15 mm. for figure 130; 0.18 mm. for figure 131.

17(15+2)/17−9(5+2+2)/9−10(6+2+2)/7 (5+2); left tarsus 4 possibly regenerated after damage.

GENITAL MORPHOLOGY: Penis (figs. 107–121) like that of *levipes,* no significant differences.

Female from Barton Flats, California (figs. 125, 126): Similar to male with usual differences. Palpi as in figure 129, more slender than in male, lacking glandular areas; femora about 8.5 times, patella 4.5 times, tibiae 3.5 times as long as thick. Genital morphology: Evidently one pair of seminal receptacles (fig. 131).

MEASUREMENTS: All measurements are in millimeters:

MALE HOLOTYPE: Total length, 3.6. Length less hood, 2.9. Breadth of abdomen, 2.0. Appendages as in table 14.

Female from Barton Flats: Total length, 3.8. Length less hood, 3.1. Breadth of abdomen, 2.2 Appendages as in table 15.

VARIATION: Variations in meristic characters are summarized in table 16. The pseudoarticulations of the second femora usually number five or six in males, but range from three to nine; in females the range is four to eight, but five or six seem still to be the commonest numbers. Whereas the first femora never have pseudoarticulations, the third femora sometimes do, and two males from Claremont had -/1 and 1/2. The fourth femora of the holotype lacked pseudoarticulations, but one or two occur in other specimens; one specimen had three. Tibiae 2 may have no pseudoarticulations, or as many as six (!), but three or four is the usual number. Metatarsi 2 have four to seven, mostly five. Many specimens were damaged, so we prefer

TABLE 14
Leg and Palpal Segments of Male Holotype of *Ortholasma setulipes*
(Measurements in millimeters.)

	Legs				
Segment	1	2	3	4	Palpus
Trochanter	—	—	—	—	0.36
Femur	1.6	2.9	1.9	2.6	0.89
Patella	0.5	0.7	0.6	0.8	0.57
Tibia	1.2	2.4	1.4	2.3	0.47
Metatarsus	1.1	2.3	1.2	1.6	—
Tarsus	1.2	2.3	1.2	1.5	0.34

TABLE 15
Leg and Palpal Segments of Female *Ortholasma setulipes* from Barton Flats
(Measurements in millimeters.)

	Legs				
Segment	1	2	3	4	Palpus
Trochanter	—	—	—	—	0.35
Femur	1.5	2.7	1.8	2.3	0.85
Patella	0.5	0.7	0.6	0.8	0.56
Tibia	1.1	2.2	1.4	2.1	0.47
Metatarsus	1.1	2.1	1.2	1.5	—
Tarsus	1.1	1.9	1.1	1.3	0.35

TABLE 16
Variation in Meristic Characters in *Ortholasma setulipes*
(Measurements in millimeters.)

Measurement	Range	Mean and S.D.
Total body length:		
Males (n = 22)	3.2–3.8	3.60 ± 0.16
Females (n = 13)	3.5–4.3	3.95 ± 0.27
Length less hood:		
Males	2.7–3.1	2.99 ± 0.11
Females	3.0–3.7	3.35 ± 0.23
Breadth of abdomen:		
Males	2.6–3.1	2.87 ± 0.12
Females	2.0–2.6	2.38 ± 0.17
Length of femur 2:		
Males	2.6–3.1	2.87 ± 0.12
Females	2.5–3.0	2.69 ± 0.16
Penis length (n = 8)	1.49–1.72	1.62
Total length/length less hood:		
Males	1.14–1.27	1.20
Females	1.15–1.23	1.18
Total length/breadth of abdomen:		
Males	1.74–1.95	1.83
Females	1.50–1.75	1.66
Total length/length of femur 2:		
Males	1.10–1.36	1.25
Females	1.33–1.68	1.47

to make no statements regarding variation in tarsal numbers; the specimens described are probably typical.

The form of the hoods (figs. 122–126) is relatively constant, but there is some variation in outline from specimens with typically spoon-shaped hoods with convex lateral margins to some with straight-sided or concave lateral margins. The broadest hood was seen in a male from Old Baldy, the narrowest in three males from Borrego Canyon (fig. 123); the Barton Flats female had a hood more ascending when seen lateral view (fig. 126) than the others. The number of fenestrations above the eyes ranges from seven to 10 on each side. The keel patterns are remarkably uniform, but the scute spination is variable; some with long, tapering spines, others more knoblike. This might be a function of age and, consequently, abrasion. There was little color variation.

Again, small sample size makes it difficult to compare samples and get a picture of geographic variation. Generally, this species is less variable than *levipes* or *rugosum,* but differences between samples point to some possible constant population differences between the Claremont specimens and those from Borrego Canyon. This should be investigated further.

RELATIONSHIPS: *Ortholasma setulipes* is very closely related to *O. levipes,* the only really striking constant difference being in the microsculpture of the legs. Other differences are of a qualitative nature, for example, *setulipes* has rather longer legs in proportion to body length and seems to have higher tarsal numbers. The leg femora have fewer pseudoarticulations, always lacking them on femur 1 and frequently so on femur 3. The palpal femora of the males of *setulipes* are more slender and have poorly developed glandular areas, whereas the palpal patellae in this species are somewhat thicker than in *levipes.* There are no clear differences in the chelicerae of the males, and, surprisingly, in the penes. We think full species status is warranted by the syntopic occurrence of *setulipes* and *levipes* at two localities without evidence of intergradation, especially when the obvious constant difference in leg microsculpture is considered. *Ortholasma coronadensis* (see below) evidently belongs to this group; one of our new names might fall as synonym of *coronadensis* if the type ever becomes available or if new specimens are found.

DISTRIBUTION: Southern California, specifically San Luis Obispo, Los Angeles, San Bernardino, Orange, and San Diego counties, largely in the southernmost Coast Ranges, transverse ranges and peninsular ranges west of the driest deserts. This region has been typified by Linsley (1958) as "Californian." The species might eventually be found in the northern part of Baja California.

RECORDS: CALIFORNIA: *San Diego Co.:* San Diego, in pitfall traps, Nov. 1971, Jan. to Apr. 1972 (B. Kaston), 3♂♂, 3♀♀ (WAS). *Orange Co.:* Laguna Beach, Laguna Canyon, July 9, 1915 (N. Banks), 2♂♂, 2♀♀ (MCZ). *Los Angeles Co.:* Claremont (no further data), 16♂♂, 10♀♀ (MCZ); Old Baldy, San Bernardino Mts., May 7, 1936 (no collector's name), ♂ (AMNH). *San Bernardino Co.:* Barton Flats Recreation Area, June 11, 1964 (G. Noonan), ♀ (AMNH). *San Luis Obispo Co.:* Reservoir Canyon, near San Luis Obispo, Aug. 15, 1959 (W. Gertsch, V. Roth), ♂ (V. Šilhavý Coll.).

ECOLOGY: There are few data on collection labels. Briggs and Hom (1966) say they collected this species at the same place as the endemic schizomid *Trithyreus borregoensis,* near Borrego Springs in a palm canyon. Other localities suggest that the species is a "canyon dweller," finding needed moisture in these refuges; the vegetation in them is usually of the Upper Sonoran type. Barton Flats, at an elevation of 1800 m., is in the Transition Zone.

ETYMOLOGY: The specific epithet is a Latin adjective indicating that the femora of this species are armed with fine, hairlike setae.

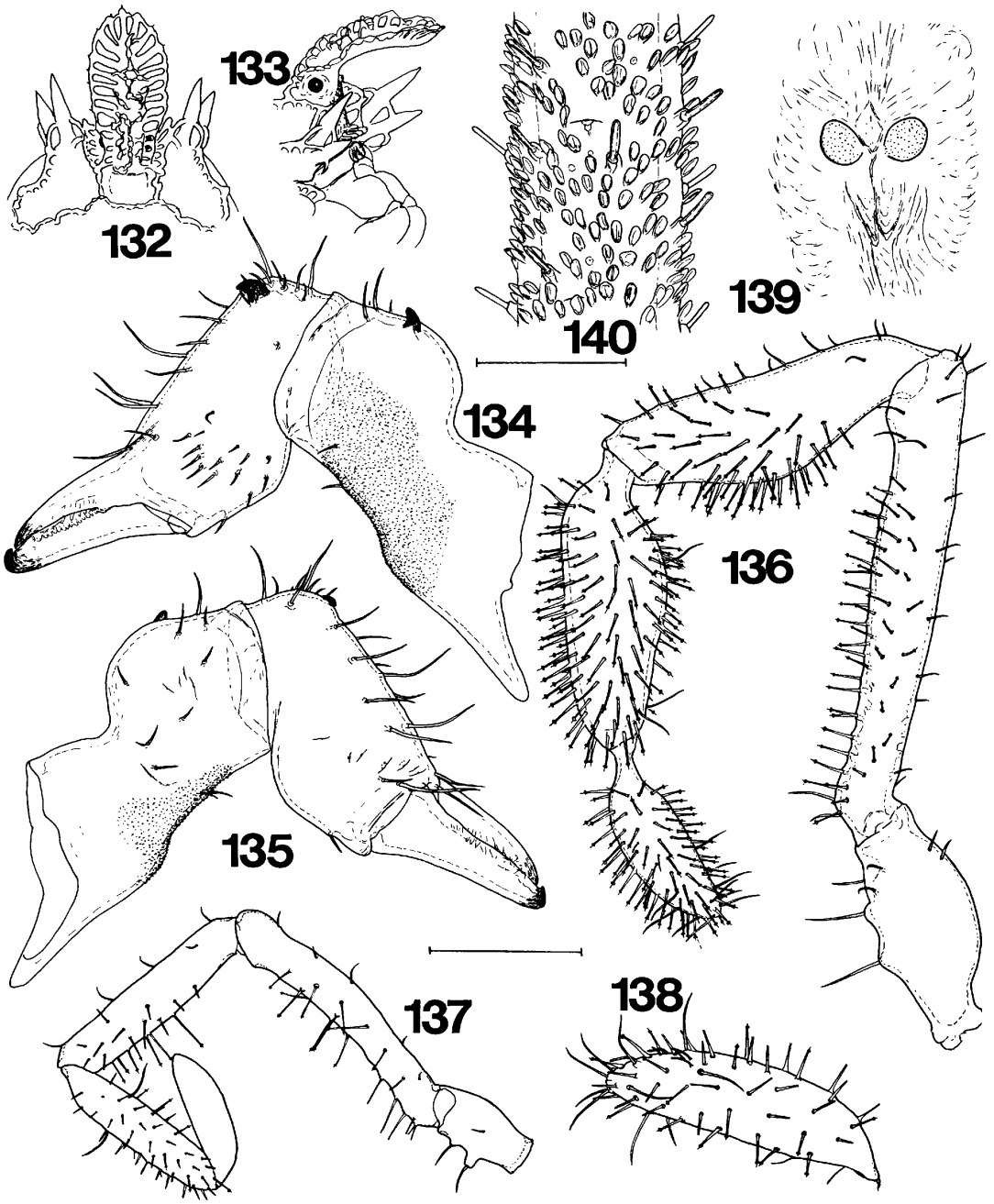
Ortholasma bolivari (Goodnight and Goodnight), new combination

Figures 6, 12, 132–145; Map 3

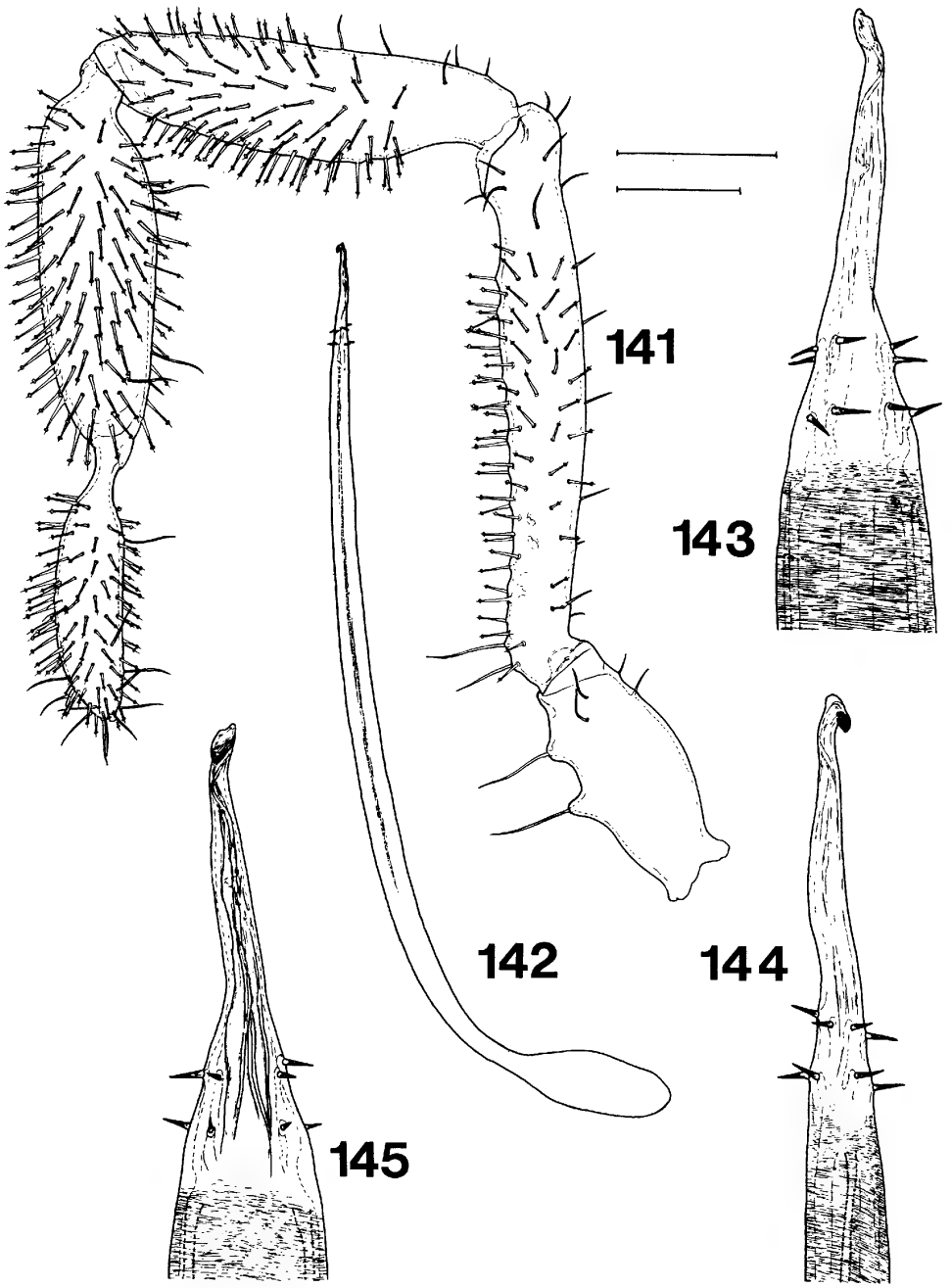
Trilasma bolivari Goodnight and Goodnight, 1942, p. 7, figs. 16–18; 1945a, p. 8. Roewer, 1950, p. 56.

Ruaxphilos petrunkevitchou Goodnight and Goodnight, 1945b, p. 250, figs. 1, 2. Roewer, 1950, p. 11.

TYPES: Holotype and paratypes of *T. bolivari* from Rio Frio, Puebla, México (AMNH);



FIGS. 132–140. *Ortholasma bolivari.* 132. Hood of male paratype, dorsal. 133. Same, lateral view. 134. Right male chelicera, mesal view. 135. Same, lateral view. 136. Right male pedipalp, mesal view. 137. Right pedipalp of holotype of *Ruaxphilos petrunkevitchou* (=*O. bolivari*). Note presence of clavate hairs. 138. Palpal tarsus of same, enlarged. Note clavate hairs, lack of claw rudiment. 139. Seminal receptacles of *O. bolivari.* 140. Microsculpture of second leg femur. Scales lines = 1.0 mm. for figures 132, 133; 0.35 mm. for figures 134, 135; 0.25 mm. for figures 136, 137; 0.13 mm. for figure 138; 0.18 mm. for figure 139; 0.15 mm. for figure 140.



FIGS. 141–145. *Ortholasma bolivari.* 141. Right pedipalp of female, mesal view. 142. Entire penis, lateral view. 143–145. Penis tip. 143. Dorsal view. 144. Lateral view. 145. Ventral view. Upper scale line = 0.25 mm. for figure 141. Lower scale line = 0.5 mm. for figure 142; 0.1 mm. for figures 143–145.

holotype of *R. petrunkevitchou* from Las Vegas, Vera Cruz, México (FMNH).

SYNONYMY: A separate genus *Trilasma* seems superfluous when one considers the close resemblance of all *Ortholasma* species and the strong differences between the latter

genus and *Dendrolasma*. But in order to suggest the differences between the Mexican and North American species groups of *Ortholasma, Trilasma* may be retained as a subgeneric name. As such, species of the subgenus can be diagnosed by the highly arched hood tuberculate over its dorsal surface. *Ruaxphilos petrunkevitchou* is based on a juvenile and was erroneously placed in the Ischyropsalididae. Its true placement was first recognized by Shear (1975b). Our synonymy is based primarily on geographical grounds; at present it is not possible to assign young specimens to species with certainty.

DIAGNOSIS: The highly arched hood with dorsal projections sets off this species from the California *Ortholasma* species; the lack of troglobitic adaptations separates it from *O. sbordonii,* also of México.

DESCRIPTION: Male from Llano Grande: Color uniformly blackish brown, scute with darker spots indicating muscle insertions. Body form (fig. 6) typical, second thoracic tergite clearly set off by anterior and posterior membranous folds. Hood highly arched (figs. 12, 132, 133), median process inserting nearly dorsally on eye tubercle, ascending rostrad in semicircular curve so that distal part approaches horizontal, with continuous rim of elongated tubercles inserted laterally. These have small heads bearing distinct small setae and number 10 on each side, making nine fenestrations distal to eyes. Hood outline in dorsal view (fig. 132) relatively narrow, with nearly parallel sides, maximum breadth about 1.5 times breadth immediately above eyes. Well-developed supraocular keels hide eyes from above. Dorsal surface of median process with irregular longitudinal rows (usually two or three) of low, anvil-shaped tubercles, connected to each other by transverse bridges and partially to lateral rim tubercles. Dorsal side of eye tubercle also with processes. Large lateral carapace processes conical-acute, connected with circumocular keel by higher tubercles continuing on enlarged third spine, lower than large lateral ones. Tubercles of keels generally high, short setae on heads easily seen. Front wall of carapace below hood with two transverse keels, upper one acutely angled dorsad, with two lateral connecting keels angled mediad. Laminae supracheliceral with sculpture less well developed, median part with two small warts, lateral pieces with single warts on ventrolateral edges. Pleural sclerites inconspicuous, especially when compared to other species. Carapace keels as usual. Transverse keel of first thoracic segment with five pointed spines; thoracic tergite 2 with a similar arrangement. Caudal keel of scute with protruding, conical-acute spines; areas 1–4 each with median, transversely oval or polygonal cells. A little behind these on each side is another large cell; another row of larger cells caudal to these, giving the appearance of four segmentally transverse arches of larger cells. Area 5 with cells more rectangular, scute between these cells covered by typical small keel lattice, especially in the median region. Keel lattice restricted generally to regions between first four areas, best developed near median line. Scute spines in paramedian pairs on areas 1–4. Free tergites with transverse rows of lower anvil-shaped tubercles, becoming wartlike on tergite 8 and corona analis.

Free sternites with transverse rows of wartlike tubercles, each with a seta. Coxal surfaces similar to sternites.

Chelicerae as in figures 134, 135. Basal article 0.79 mm. long, with distal part broader, with a dorsally rounded hump set sparsely with setae; glandular area lacking. Dorsomedial tooth present. Second article 0.75 mm. long, with usual apophysis. Pedipalp as in figure 136. Femur relatively slender and straight, nearly seven times longer than broad, ventromedial side with clavate hairs. Patella about 3.2 times longer than broad, curved, with clavate hairs on ventral side. Tibia nearly three times as long as broad, with clavate hairs. Tarsus elongate-oval, with usual setation.

Legs with coxae as usual, fourth coxa with elongated tubercle on prolateral side. Trochanters with seta-bearing warts. Second femora more slender than others; first and third femora especially stout, no evidence of pseudoarticulations. Tibiae without pseudoarticulations. Microsculpture: longitudinal rows of short, blunt, rounded setae on small warts (these longer on tibiae); microdenticles rather uniform (fig. 140), obliquely projecting, somewhat spoon-shaped, but flattened dorsoventrally (these more slender on tibiae). Metatarsi and tarsi with dense cover of

microtrichia, longer acute setae. Metatarsus 2 with two or three subarticulations. Tarsi: 5(3+2)–7(5+2)/4(abnormal)–7(3+2+2)/3 (abnormal)–7(3+2+2).

GENITALIA: See figures 142–145. Penis shaft slender, 1.7 mm. long; glans symmetrical, conical, with uniform acute setae, stylus gradually tapering from glans, about 1.5 to 2 times as long as glans proper, with apical hook and pale, membranous dorsal zone.

FEMALE: Similar to male, with the usual sexual differences; see measurements. Genital operculum broad, rounded, with apical transverse polished lip. Chelicerae without cuticular teeth on first and second articles. Palpi similar to those of male, but patella with slightly different proportions. Legs: second metatarsi in females studied as follows: 0/0, 2/2, 3/f. Tarsal segment numbers for the same animals: 5–5/6–f/7–7/8, 6–9/10–7/8, 5/6–8–8–8, 5/6–9/f–8–7/8. Ovipositor of typical form about 1.2 mm. long and 0.35 mm. wide; receptacula as in figure 139.

MEASUREMENTS: Standard measurements of the described male and four associated females are given in table 17, appendage measurements in tables 18 and 19.

VARIATION: Only a few specimens were available for us to study, and these were mostly females. One female with a thick body had the membranes anterior and posterior to thoracic tergite 2 strongly distended, and the tergite subdivided near the median line by a strip of pale cuticle, which also interrupted the median keel. One female (#2 in the table of measurements) had relatively shorter legs and lower tarsal counts. This same female differed from all others seen in having a single row of tubercles on the median hood process and a more richly developed small lattice over the dorsum. Under the heading "unassigned specimens," we discuss a female from Chipinque Mesa, San Luis Potosí, which seems to represent a third Mexican species. It is rather like this unusual female of *O. bolivari.* Minor differences in dorsal ornamentation occur, largely having to do with the distribution of the smaller lattice pattern. The single available male had two tarsi with segment numbers lower than normal.

JUVENILE STAGES: Only the holotype of *Ruaxphilos petrunkevitchou* was examined. It is largely as described by Goodnight and Goodnight (1945a), but the clavate hairs of the pedipalpi (figs. 137, 138) are less dense than shown in their illustration, and the tarsi likewise are not swollen. The presence of clavate hairs alone excludes this form from the Ischyropsalididae.

RELATIONSHIPS: The closest relative *bolivari* is surely *sbordonii,* which differs from *bolivari* in having striking troglobitic adap-

TABLE 17

Male *Ortholasma bolivari* from Llano Grande, and of Four (#1-#4) Females from the Same Collection

(Measurements in millimeters.)

MEASUREMENTS	♂	♀1	♀2	♀3	♀4
Total length	3.3	3.7	3.0	3.9	3.6
Scute length	2.6	2.9	2.5	3.1	3.0
Breadth of abdomen	1.7	2.0	1.7	2.0	2.1
Length of femur 2	2.4	2.7	1.4	3.0	2.9

TABLE 18

Leg and Palpal Segments of Male *Ortholasma bolivari* from Llano Grande

(Measurements in millimeters.)

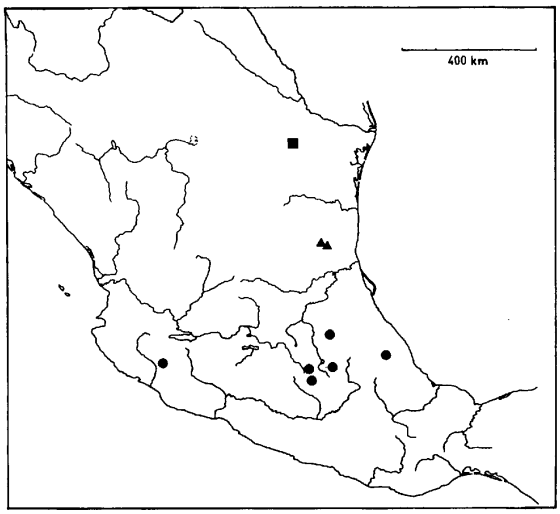
	LEGS				
SEGMENT	1	2	3	4	PALPUS
Trochanter	—	—	—	—	0.37
Femur	1.3	2.4	1.4	2.0	0.88
Patella	0.6	0.7	0.6	0.7	0.60
Tibia	1.0	1.8	1.0	1.9	0.53
Metatarsus	0.8	1.7	0.8	1.0	—
Tarsus	0.9	1.5	0.9	1.1	0.34

TABLE 19

Leg and Palpal Segments of Female *Ortholasma bolivari* (#1 in table 17) from Llano Grande

(Measurements in millimeters.)

	LEGS				
SEGMENT	1	2	3	4	PALPUS
Trochanter	—	—	—	—	0.39
Femur	1.4	2.7	1.6	2.1	0.97
Patella	0.6	0.7	0.6	0.7	0.71
Tibia	1.0	2.2	1.1	2.0	0.63
Metatarsus	0.9	2.1	0.9	1.1	—
Tarsus	1.1	1.8	1.1	1.3	0.41



MAP 3. Central and northeastern Mexico, showing distribution of *Ortholasma* species. Dots, *O. bolivari*. Triangles, *O. sbordonii*. Square, specimen from Chipinque Mesa (see text). Not all records for *O. bolivari* appear on this map; see Goodnight and Goodnight (1945a).

tations, such as reduced eyes, attenuated appendages, and pale pigment. However, hood form, body ornamentation and leg microsculpture are independent differences and therefore more valuable. The Mexican species of *Ortholasma* might be more primitive. The highly arched dorsum, the elevated and curved hoods, longer, more homonomous palpi without glands in males, and the simpler scute patterns resemble juveniles of California *Ortholasma*. On the other hand, the lack of cheliceral glands in the males is an apomorphy.

DISTRIBUTION: See map 3. We were not able to map some of the localities in Goodnight and Goodnight (1942, 1945a). All the known localities are in the southern part of the Mexican highlands, in the region Goldman and Moore (1946) called the "Transverse Volcanic Biotic Province." The Nevada de Colima locality is relatively isolated from the others. We have no new records; all the specimens we saw were listed by Goodnight and Goodnight (1942, 1945a), and are in the AMNH collection.

ECOLOGY: According to the sparse data on the collectors' labels of the material we looked at, the species is found at elevations around 3000 m., in forests of spruce, fir, oak, and pine. The localities fall into the zone of dry oak and pine forests (Shelford, 1963; Knapp, 1965), the most widely distributed vegetation type of the Mexican highlands, but also reach into the subalpine coniferous forests (Knapp, 1965). The species is thus associated with vegetational types of a Holarctic character.

Ortholasma sbordonii Šilhavý

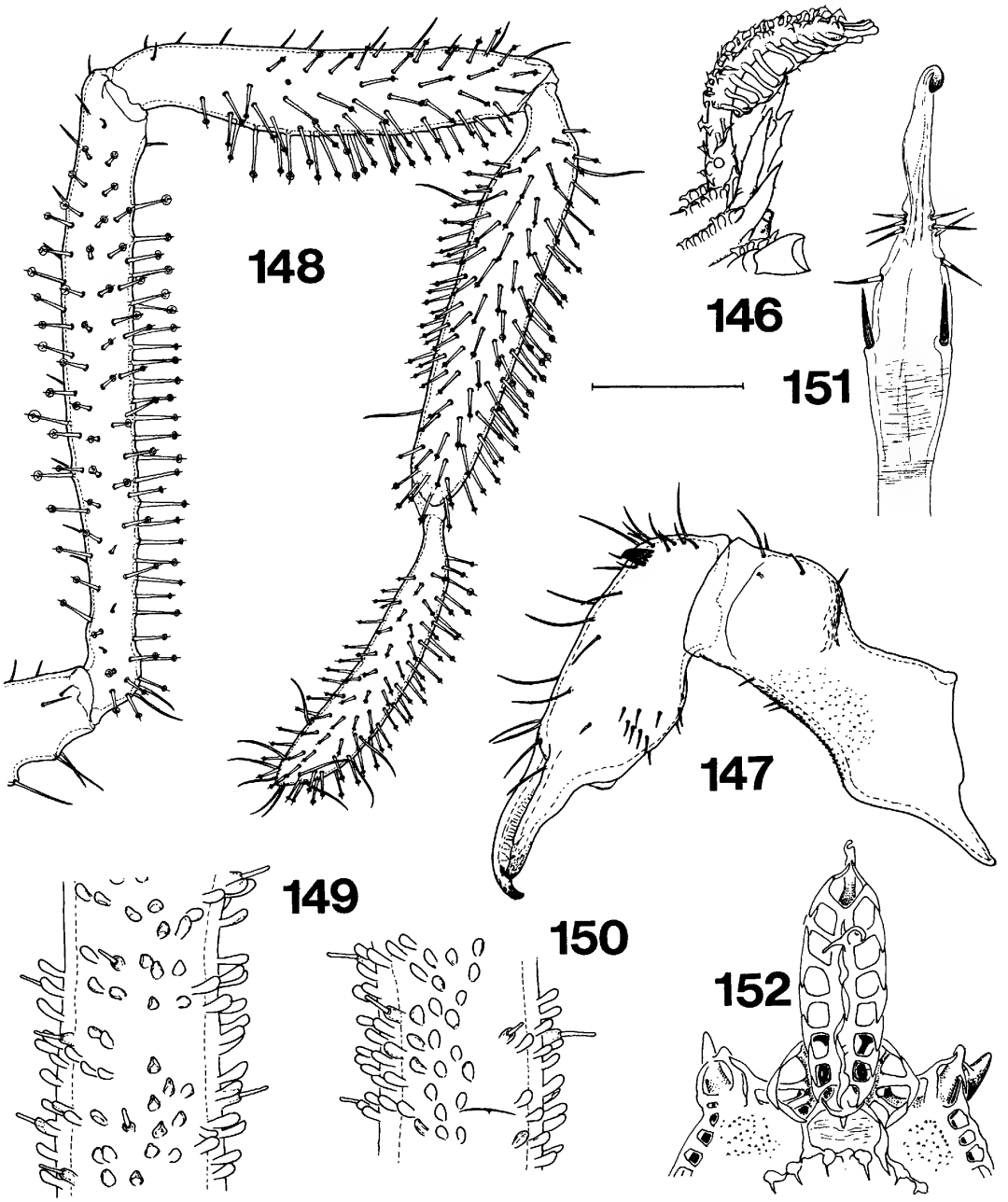
Figures 7, 13, 15–17, 146–151; Map 3

Ortholasma sbordonii Šilhavý, 1973, p. 191, figs. 43–49.

TYPES: Male holotype and male and female paratypes from Cueva de la Perra, Goméz Farias, Tamaulipas, México, deposited in Zoological Institute of the University of Rome, Rome, Italy; paratypes in the personal collection of V. Šilhavý, Třebíc, Czechoslovakia.

DIAGNOSIS: Distinct from the related allopatric *O. bolivari* in its troglobitic adaptations, as well as differences in leg microsculpture (see figs. 149, 150) and the shape of the penis.

DESCRIPTION: The original description was complete and well illustrated, but requires some expansion for comparative purposes; the following is drawn from a study of the types, supplemented by two males from the type locality (WAS). Color tan to medium brown, surface thinly covered with soil. Eyes not pigmented, small, on distinct stalks. Eye tubercle reduced in girth, forming only slightly widened base for median hood process (fig. 146) arising nearly vertically from anterior carapace margin, highly arched, curving anteriorly to horizontal. Hood 1 mm. broad at widest point, median process only 0.13 mm. broad; lateral tubercles (fig. 17) long, thin, about 13 on each side above eyes, heads small but with distinct setae and long well-developed arms. Dorsal surface of median hood process with three or five irregular rows of lower anvil-shaped tubercles (fig. 13), these often three- or four-pronged, interconnected. Supraocular keel not distinct. Subocular keels consisting only of few high tubercles connected posteriorly to two longitudinal carapace keels. Lateral processes of carapace long,



FIGS. 146–152. *Ortholasma sbordonii* and *Ortholasma* sp. 146–151. *O. sbordonii.* 146. Hood, lateral view, male from type locality. 147. Right chelicera of male, mesal view. 148. Left pedipalp of male, mesal view. 149. Microsculpture of second leg femur, in basal third of femur. 150. Same, but in distal third of femur. 151. Penis tip, ventral view. 152. Hood of *Ortholasma* sp. female from Chipinque Mesa, dorsal view. Scale line = 1.0 mm. for figure 146; 0.35 mm. for figure 147; 0.15 mm. for figures 149, 150; 0.2 mm. for figure 151; 0.85 mm. for figure 152.

pointed, distal portions with scattered small setae. Anterior wall of carapace below hood with much reduced, indistinct transverse keels. Scute pattern of carapace (fig. 7) as

usual. Scutum with keel pattern somewhat more irregular than shown by Šilhavý's figure 43, larger, often irregular cells in four transverse, curved series on areas 1–4, larger ones on area 5. Scute between cells covered with typical small keel lattice (fig. 15). Scute spines practically lacking. Posterior marginal keel of area 5 more or less erect. Ventral coxal surfaces also with conical tubercles, but some of them with marked arms, especially apicolaterally.

Chelicerae as in figure 147. Basal article lacks glandular area and dorsomedial tooth. Second article with hooked apophysis. Pedipalp as in figure 148, long and relatively slender, femur about 8.6 times as long as broad, patella 5.0 times, tibia 5.3 times as long as broad. Clavate hairs on all articles, including ventro-median side of femur; glandular tissue evidently absent.

Legs with trochanters bearing conical tubercles tipped by blunt setae, between these are microdenticles. Femora cylindrical, slender, first stouter than the others, lacking pseudoarticulations. Patellae and tibiae similar, tibiae without pseudoarticulations. Microsculpture (figs. 149, 150) consisting of erect, short, club-shaped microdenticles and short, blunt, rounded setae on low papillae in rows. Second metatarsus with 7/6 pseudoarticulations; metatarsi and tarsi with microtrichia and longer, pointed setae. Tarsal segment numbers: 10?(eight remaining, distitarsus lacking)/10(8+2)–23(21+2)/26(24+2)–10(6+2+2)/10–missing/10(6+2+2). Šilhavý (1973) gives higher numbers and may have included some metatarsal segments in his counts.

GENITAL MORPHOLOGY: Generally like that of *bolivari,* but surprisingly, there are two enlarged setae at the base of the glans (fig. 151) that point rigidly distad. This must be a development parallel to the heteronomous setation found in *Dendrolasma.*

FEMALE ALLOTYPE: Generally similar to male, median hood projection damaged, so that some laterodistal processes are missing. Genital operculum missing. Dorsal keel pattern like that of male. Chelicerae lacking hook on second article. Palpi similar to male, femora about 8.4 times, patellae 5.3 times, tibiae 5.6 times as long as thick. Legs: metatarsus 2 with 10/8 pseudoarticulations; tarsal numbers: 10(8+2)/9(7+2)–18(16+2)/16(14+2)–9(5+2+2)/9–10(6+2+2)/10. Genital morphology: See Šilhavý (1973) for figures of ovipositor and seminal receptacles.

TABLE 20
Leg and Palpal Segments of Male Holotype of *Ortholasma sbordonii*
(Measurements in millimeters.)

	LEGS				
SEGMENT	1	2	3	4	PALPUS
Femur	2.0	5.1	2.5	3.4	1.13
Patella	0.7	0.9	0.7	0.8	0.77
Tibia	1.4	4.2	1.7	3.2	0.77
Metatarsus	1.3	4.3	1.1	1.4	—
Tarsus	1.4	3.5	1.4	1.5	0.55

MEASUREMENTS: All measurements are in millimeters:

MALE HOLOTYPE: Overall length (scute length with hood, including sculpture), 3.3 (dorsal view: elevated hood makes measurements difficult!); same without hood, 2.3; abdomen breadth, 1.7; cephalothorax breadth, 1.3. Hood maximal breadth, 1.0; breadth of median projection without lateral processes, 0.13. Measurements of appendages as in table 20.

FEMALE (ALLOTYPE): Overall length with free tergites, 3.6; without free tergites (corresponding to overall length of male), 3.3; same without hood, 2.4. Abdomen breadth, 1.7. Cephalothorax breadth, 1.4. Measurements of appendages in table 21.

VARIATION: Too few specimens are available to allow us to make any meaningful remarks.

JUVENILE STAGES: One juvenile from the type locality is known (WAS); it seems to be

TABLE 21
Leg and Palpal Segments of Female Allotype of *Ortholasma sbordonii*
(Measurements in millimeters.)

	LEGS				
SEGMENT	1	2	3	4	PALPUS
Femur	1.9	5.0	2.5	3.4	1.18
Patella	0.6	0.9	0.7	0.8	0.83
Tibia	1.4	4.0	1.7	3.1	0.83
Metatarsus	1.2	4.0	1.2	1.5	—
Tarsus	1.4	3.2	1.4	1.6	0.60

at least two molts removed from maturity. It is yellow-white, unpigmented, oval in outline and with a finely granulated surface. The eyes are small, on the base of an eye tubercle with a short, curved dorsal projection bearing two or three lateral and dorsal warts. Body length, 2.1 mm., breadth 1.1 mm., femur of second leg 3.5 mm. long.

RELATIONSHIPS: The species is clearly related to *O. bolivari,* but shows troglobitic adaptations and quite a different microsculpture on the legs. Eye reduction in *sbordonii* has not been followed by the reduction of the eye tubercle or hood, suggesting that some independent function is served by this structure.

DISTRIBUTION: Known only from two caves in the Sierra Madre Oriental region of México, both near the village of Goméz Farias. Cueva de la Perra, the type locality, is at an elevation of 2160 m., and Cueva de la Mina at an elevation of 1600 m. Because of their elevated situations, these caves are of a temperate not tropical type. Both have exceedingly rich troglobitic faunas.

Ortholasma coronadense Cockerell
Map 1

Ortholasma coronadensis Cockerell, 1916, p. 158.
Roewer, 1923, p. 649.

TYPES: "Holotype specimens" from South Island, Coronados Group, Baja California, Mexico, in Cockerell Collection, probably lost.

This species has not been found again since its original description. We were unable to locate the type material, and so, since the description by Cockerell (1916) does not mention many characters we now know to be crucial, we are unable to place this name in our system. It is possible that one of our new species (*setulipes*) may be a synonym. Cockerell, however, described the hood as being nearly circular in form, a characteristic which suggests that it may be a species we have not seen. We have no other Baja California records. On the other hand, the Coronados Islands are near the coast (*C,* map 1) and were probably connected to the mainland in the last Wisconsin glacial maximum (Thorne, 1969), so endemism seems less probable.

UNASSIGNED SPECIMENS OF *ORTHOLASMA*

In the course of our studies we came across two specimens, both females, which we believe to represent two undescribed species of *Ortholasma.* Because only a single female specimen is available from each of these supposed species populations, we choose not to name and describe them now. We will, however, provide a few descriptive notes and illustrations for the guidance of future collectors.

One of these specimens is a single female (AMNH) collected by W. Gertsch and V. Roth on September 15, 1959, 2.5 mi. E of California Hot Springs, Tulare Co., California (*S,* map 1). This locality is at the western foot of the southern Sierra Nevada, in the Greenhorn Mountains. We have no data on ecology. The specimen is remarkably large (total length, 5.2 mm.; length without hood, 4.1 mm.; breadth of abdomen, 3.3 mm.; leg femora, 1.8, 3.6, 2.2 and 2.9 mm. long, respectively). The form of the hood and scute is similar to that of *O. rugosum.* The femora and tibiae of the legs lack pseudoarticulations and have only a slightly bumpy outline; the microsculpture of the femora differs in that the denticles are less clustered and more acute. Metatarsi 2 have 9/8 pseudoarticulations. Tarsomere numbers: 9(7+2)–10(8+2)/11 (9+2)–10(6+2+2)/9(5+2+2)–10. We think this specimen represents a new species related to *rugosum,* but with differences in size, leg microsculpture, palpal proportions and (to some extent) scutal armature.

The second specimen (WAS) was collected on June 24, 1969, by S. and J. Peck, on Chipinque Mesa, near Monterrey, Nuevo Leon, México (map 3). This specimen probably represents a new species in the subgenus *Trilasma.* It differs from *sbordonii* in having a much narrower hood of stouter processes and in lacking troglobitic adaptations. It differs from *bolivari* in having but a single, relatively orderly row of dorsal hood tubercles, which are clearly joined to each other (fig. 152). In

addition, the keels and armature of the scute are much better developed. The specimen is smaller than those of *bolivari* we studied (total length, 2.7 mm.; length without hood, 2.1 mm.; breadth of abdomen, 1.5 mm.). The legs, proportionally, are much shorter, with femora 1–4 being 0.84, 1.47, 0.89 and 1.51 mm. long, respectively. The second and fourth femora of the right side have a single pseudoarticulation each! The second metatarsi are missing, but the tarsal numbers are as follows: 5(3+2)/5–a/a–8(3+2+2)/8–8/8. These numbers are in the range we found in *bolivari*. This specimen is interesting from a biogeographic standpoint, as it is some distance to the north of the range of the other two species. Its presence suggests that there may be other, possibly relictual, species of *Ortholasma* in northern México.

DENDROLASMA BANKS, 1894

Dendrolasma Banks, 1894b, p. 12 (type species *D. mirabilis* Banks, by monotypy); 1901, p. 678; 1911, p. 418. Comstock, 1913, p. 80 (not seen). Roewer, 1923, p. 650; 1950, p. 54. Martens, 1976, p. 69. Bragg and Leech, 1972, p. 70. Suzuki, 1974, p. 121. Shear, 1975b, pp. 8, 11 (in key).

Cladolasma Suzuki, 1963, p. 40 (type species *C. parvula* Suzuki, by original designation); 1967, p. 5; 1972, p. 3. Suzuki and Kunita, 1972, p. 89. Martens, 1972, p. 312.

DIAGNOSIS: A genus of the Ortholasmatinae with metapeltidium joined to scute and carapace (free in *D. parvulum*), but scutum magnum not entirely complete. Carapace with one process on each side of eye tubercle at frontal border. Palpi of adults with more or less reduced numbers of clavate hairs and markedly sexually dimorphic. Glans penis with dimorphic spination, showing both large and small setae, stylus showing helical torsion.

DISTRIBUTION: Western North America, from northern California through Oregon and Washington to coastal British Columbia (southern Alaska?); one species in southern Japan (Shikoku).

RELATIONSHIPS: Evolutionary trends evident in *Ortholasma* are more developed still in *Dendrolasma*. The body is more flattened, the hoods are horizontal, and the palpal setation departs more from the juvenile pattern. Apomorphies which clearly unite the group are the sexually dimorphic palpi and polymorphic glans spination.

Dendrolasma mirabile Banks
Figures 8, 14, 153–187; Map 2

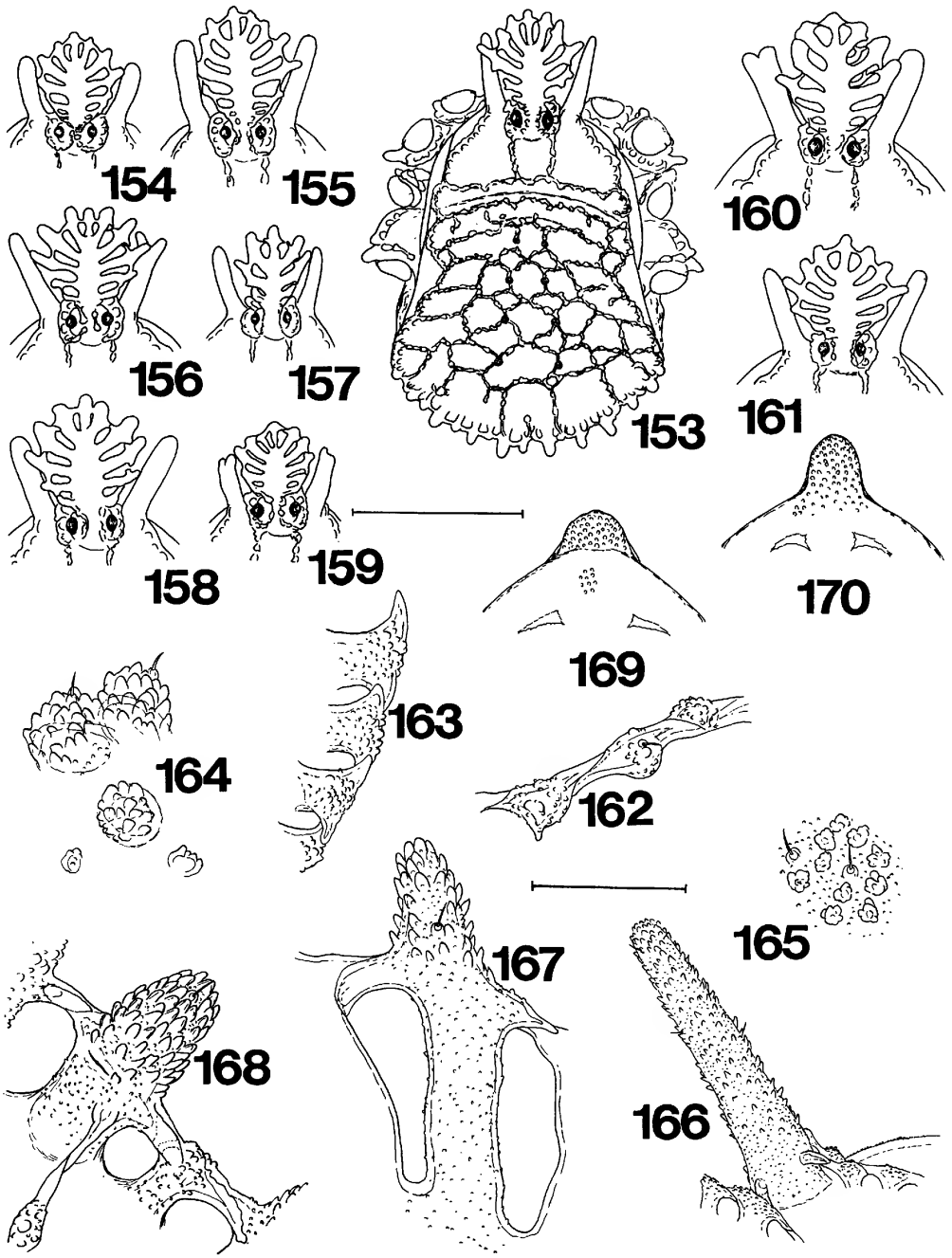
Dendrolasma mirabilis Banks, 1894b, p. 12; 1901, p. 678 (records from California probably in error), fig. 6; 1904, p. 363 (California locality in error?); 1911, p. 418 (repeats California record above), fig. 150. Comstock, 1913, p. 81 (not seen). Roewer, 1923, p. 650, fig. 813; 1950, p. 56. Bragg and Leech, 1972, p. 70. Suzuki, 1972, p. 4; 1974, p. 127.

Dendrolasma mirabile, Martens, 1978, p. 38.

TYPES: Male lectotype and female paralectotype from Olympia, Washington (MCZ).

DIAGNOSIS: An American species of *Dendrolasma* differing from *dentipalpe* in having a large-celled network of keels, as opposed to a small-celled network in the latter. Males of *mirabile* also have less exaggerated cheliceral modifications and lack the mediodistal tooth found on the palpal patella in male *dentipalpe*.

DESCRIPTION: Male from Mt. Rainier (fig. 153): Color mostly shining dark brown, nearly uniform to irregularly mottled, hood and spines lighter brown, bases of keel teeth often surrounded by lighter areas, keels themselves darker brown. Eyes ringed black. Venter brown. Palpi light brown. Leg femora with basal and apical lighter zones, patellae and tibiae similar, metatarsi and tarsi evenly brown. Body dorsally flat. Division of scute obliterated; scutum magnum present (but some specimens show faint pale suture or fold between thorax 1 and 2). Eye tubercle with rostrally inserted and directed median hood process (figs. 154–158) with large median and four or five lateral tubercles on each side, tubercles extending well beyond bridges between them. Slender, blunt-conical process on either side of eye tubercle, connected by bridge to circumocular keel. Eyes entirely visible from dorsal aspect. Front wall of carapace with one (probably the lower) transverse keel often broken up entirely into teeth or small warts. Laminae chelicerales with a row of teeth. Carapace keel pattern as



FIGS. 153–170. *Dendrolasma mirabile.* 153. Male from Mt. Rainier, dorsal view. 154–161. Hoods, dorsal views. 154. Holotype male from Olympia. 155. Another male from Olympia. 156. Male, Swift Reservoir Dam. 157. Male, McMinnville. 158. Female, Swift Reservoir Dam. 159. Female, Gold Beach. 160. Paratype female, Olympia. 161. Female, Easton. 162–168. Examples of cuticular sculpture, Mt. Rainier male. 162. Apical view of anvil-shaped tubercles from dorsal scute. 163. Marginal tubercles from first coxa. 164. Tubercles from second trochanter. 165. Warts and setae from genital operculum. 166. Right lateral hood process, dorsal view. 167. Anvil-shaped tubercle from right side of median hood process, dorsal view. 168. One in a row of projecting tubercles from posterior margin of scutum, dorsal view. 169. Genital operculum of female, ventral view. 170. Same, male. Scale lines = 0.1 mm. for figures 153–161, 169, 170; 0.13 mm. for figures 162–165, 167, 168; 0.28 mm. for figure 166.

in figures 8, 153; keels of scute generally low; metapeltidium with garland-like transverse keel. Areas 1 to 4 with one large polygonal to oval transverse median keel cell each, adjacent cells arranged segmentally; area 5 with large keel cells anterior to fencelike posterior border. Scute spines low, hardly protruding above keels, keel teeth of area 5 elongated. Free tergites with transverse rows of isolated teeth, these lower on tergite 7, tergite 8 only with rudiments. Corona analis with scattered tubercles. Free sternites with tooth rows only laterally, these reduced in the midline; genital operculum (fig. 170) short, tongue-shaped, with tubercles. Coxal surfaces with scattered tubercles and hairs, the first coxa with stronger sculpture. Pleural sclerites as usual.

Chelicerae as in figures 171–173. Basal article with distinctly broadened distal section, laterally with low warts becoming tubercles on dorsal surface, dorsal tooth small, conical, no glandular tissue or ducts evident; second article as usual, with anteriomedial apophysis of normal shape. Palpi as in figures 174, 175. Trochanters with two ventral warts bearing long setae; femora slightly curved, with pointed setae, no clavate hairs; patellae strongly thickened, ventral contour convex, belly-like, with glandular region on median side, no clavate hairs, tibiae stalked, spindle-shaped, hairs mostly short, pointed, curved setae and what appear to be reduced clavate hairs; tarsi short, spindle-shaped, stalked, without clavate hairs but densely set with pointed, curved setae.

Trochanters of legs with finely denticulate tubercles, some set with small setae; femora cylindrical, dorsal contours tuberculate, femora 2 with faintly indicated pseudoarticulations (8/12?); femoral microsculpture (fig. 180) of dense, dimorphic denticulation, mostly with narrow, distally bent "pot-handle" denticles, strongly broadened blunt denticles in transverse groups below setae, minute granulations between major denticles. Patellae with similar sculpture. Tibiae cylindrical, often with indistinct pseudoarticulations (13/17 on tibia 2, 2/2 on tibia 4), microsculpture like femora, but apical denticles more slender, setae longer. Metatarsi long, thin, metatarsus 2 with 4/5 pseudoarticulations densely covered with microtrichia and pointed setae. Tarsi with similar vestiture. Tarsal numbers: 7(5+2)/6(4+2)–10(8+2)/10–6(3+2+1)/6–6(3+2+1)/6.

Genital morphology typical for genus; penis (figs. 183–186) with slender shaft, ventromedial dark brown longitudinal stripe; glans only slightly longer than wide, six pairs of setae, setation polymorphic, with most basal pair robust, recurved; stylus thick, about twice length of glans, dorsal side membranous, ventral side sclerotized, apical third helically twisted, ductus opening terminal.

Female (from Easton, Washington): Generally similar to male, but larger and broader; even in thick-bodied females no visible widening of intersegmental sutures anterior and posterior to metapeltidium. Genital operculum (fig. 169) broadly rounded, anterior rim with shining dark brown lip. Chelicerae lacking secondary sexual characters found in male. Palpi as in figures 176, 177; femora with two to five clavate hairs on ventromedian side (these lacking in some specimens); patellae slender, cylindrical, medio-ventral side with clavate hairs; tibiae somewhat more slender than in males, covered with clavate hairs; tarsi as in male. Genital morphology typical for subfamily, but furcal sclerites and setae often darkened. Receptacula oval, saclike (fig. 182).

MEASUREMENTS: All measurements are in millimeters:

Male from Mt. Rainier: Total length, 2.9. Length without hood, 2.3. Breadth of abdomen, 1.7. Length of penis, 1.72. Appendages as in table 22.

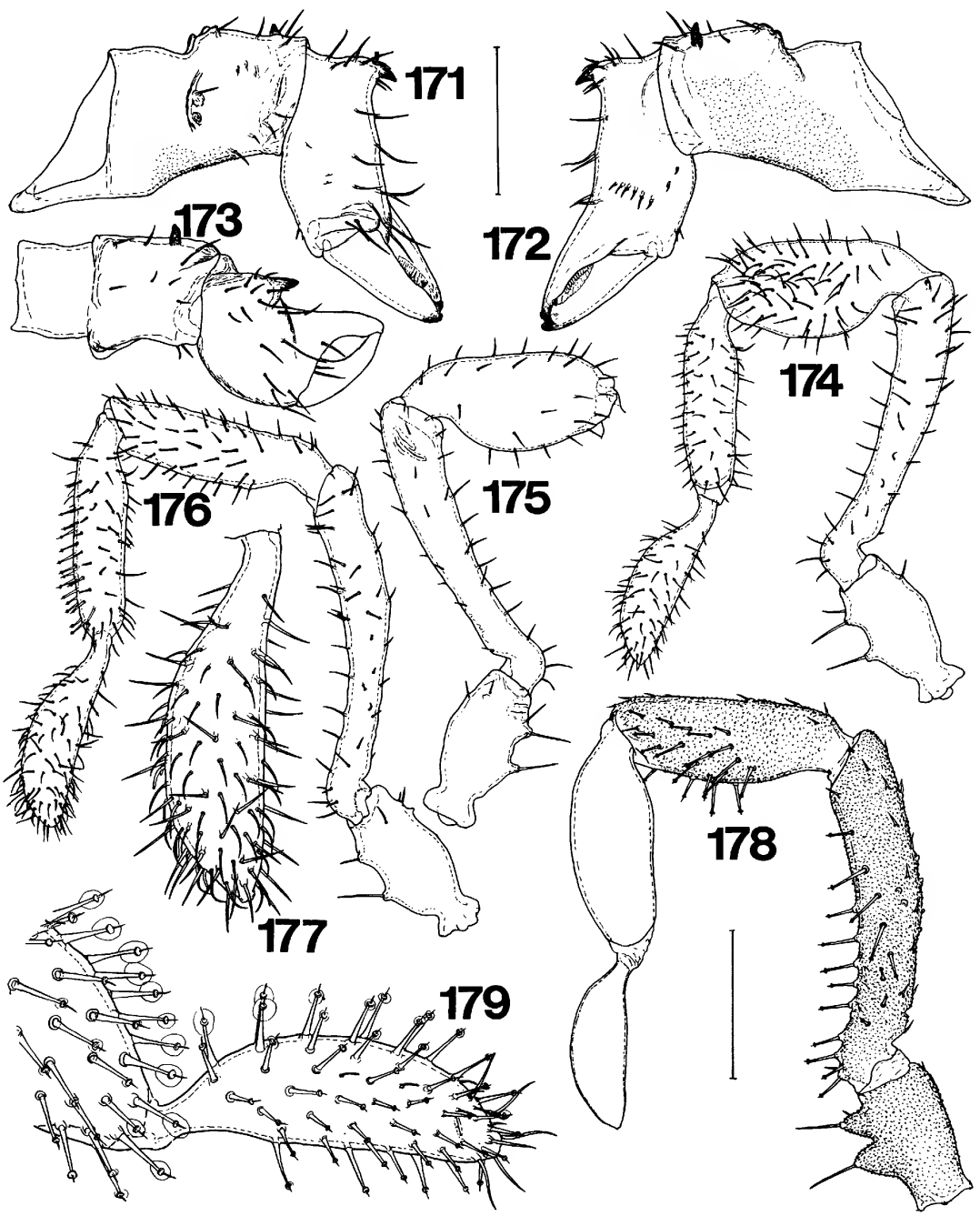
Female from Easton, Washington: Total length, 3.3. Length without hood, 2.7. Breadth of abdomen, 2.1. Appendages as in table 23.

TABLE 22

Leg and Palpal Segments of Male *Dendrolasma mirabile* from Mt. Rainier

(Measurements in millimeters.)

	LEGS				
SEGMENT	1	2	3	4	PALPUS
Trochanter	—	—	—	—	0.26
Femur	1.3	3.3	1.4	2.1	0.58
Patella	0.4	0.6	0.4	0.5	0.38
Tibia	1.0	2.8	1.2	2.0	0.37
Metatarsus	0.7	2.0	0.7	1.0	—
Tarsus	0.7	1.5	0.7	0.8	0.33



FIGS. 171–179. *Dendrolasma mirabile.* 171–173. Male right chelicera. 171. Lateral view. 172. Mesal view. 173. Dorsal view, anterior to the right. 174–179. Pedipalpi and parts of pedipalpi. 174. Male, mesal view. 175. Trochanter, femur and tibia of right male palp, lateral view. 176. Female, mesal view. 177. Tarsus of female palp. Note absence of clavate hairs. 178. Palp of subadult, mesal view. Hairs omitted from tibia and tarsus. 179. Distal end of tibia and whole tarsus of subadult palp. Note abundant clavate hairs. Scale lines = 0.35 mm. for figures 171–173; 0.25 mm. for figures 174, 175, 178; 0.13 mm. for figures 177, 179.

TABLE 23
Leg and Palpal Segments of Female *Dendrolasma mirabile* from Easton
(Measurements in millimeters.)

Segment	Legs 1	2	3	4	Palpus
Trochanter	—	—	—	—	0.27
Femur	1.3	3.2	1.4	1.8	0.64
Patella	0.5	0.7	0.5	0.6	0.42
Tibia	1.0	2.8	1.2	2.0	0.40
Metatarsus	0.8	2.0	0.7	1.1	—
Tarsus	0.7	1.5	0.7	0.8	0.36

VARIATION: Variations in meristic characters are summarized in table 24.

The pseudoarticulations found on the legs are relatively indistinct, especially on the femora, so the numbers given here may not be entirely reliable. Femur 2: three to 14 pseudoarticulations, most (57/82) have five to eight. Tibia 2: two to 17 pseudoarticulations, about half (43/85) have 12–15. Metatarsus 2: zero to eight pseudoarticulations, 15/82 have none, 33/82 have two to four. Tibia 4: zero to seven pseudoarticulations, 9/76 have none, 42/76 have one to three. There seems to be substantially less variation in tarsal segmentation in this species than in some of the others; for example, 37/53 males have six segments in the first tarsus and 36/43 females have two. In the other tarsi the range of variation is similar; males tend to have higher numbers.

TABLE 24
Variation in Meristic Characters in *Dendrolasma mirabile*
(Measurements in millimeters.)

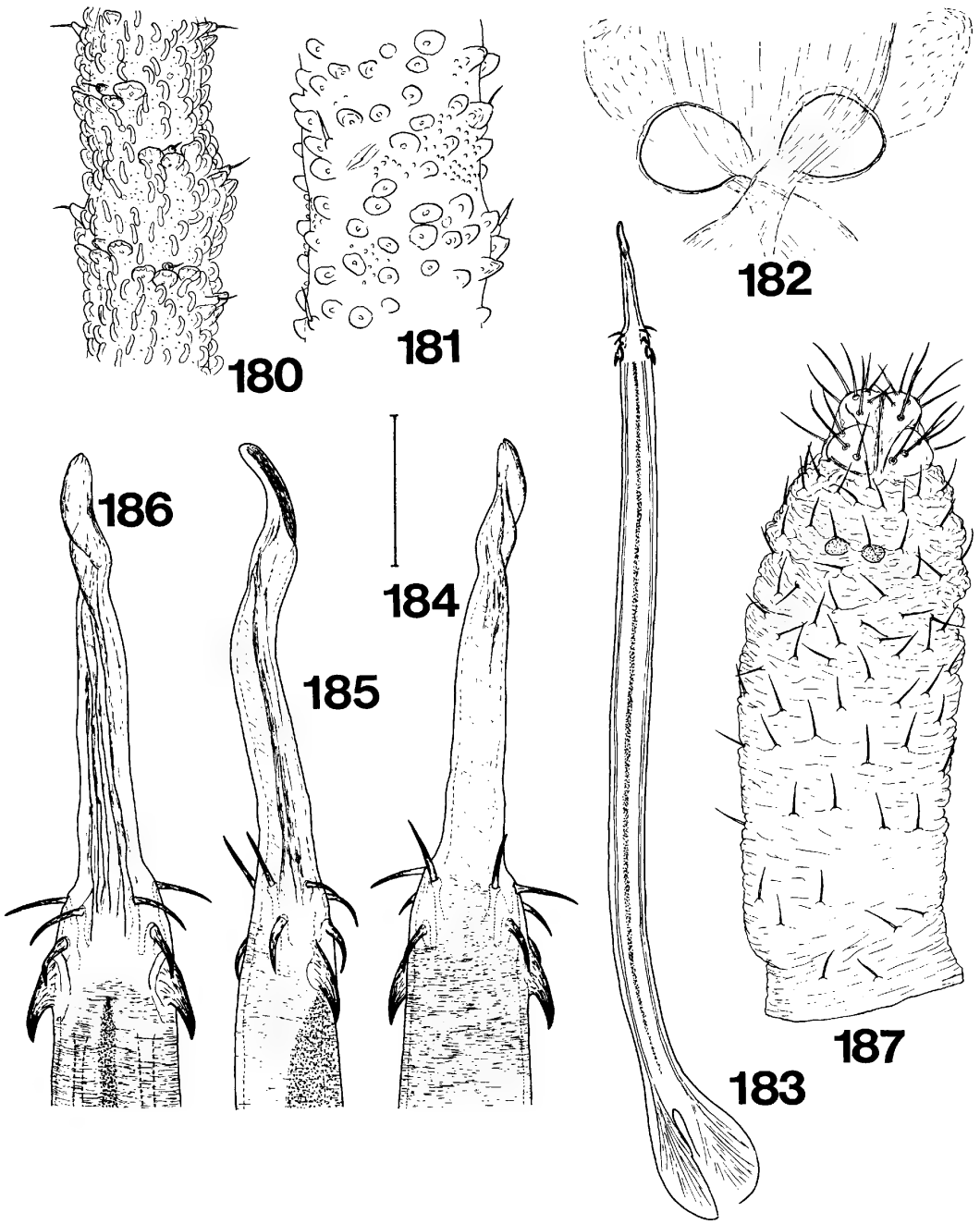
Measurement	Range	Mean and S.D.
Total body length:		
Males (n = 27)	2.4–3.3	2.75 ± 0.23
Females (n = 22)	2.8–3.9	3.34 ± 0.33
Length less hood:		
Males	2.0–2.6	2.23 ± 0.18
Females	2.4–3.1	2.75 ± 0.24
Breadth of abdomen:		
Males	1.5–2.0	1.70 ± 0.09
Females	1.7–2.6	2.10 ± 0.12
Length of femur 2:		
Males	2.6–3.6	3.07 ± 0.32
Females	2.7–3.9	3.18 ± 0.32
Total length/length less hood:		
Males	1.17–1.29	1.23
Females	1.16–1.27	1.22
Total length/breadth of abdomen:		
Males	1.50–1.72	1.62
Females	1.45–1.78	1.59
Total length/length of femur 2:		
Males	0.81–1.00	0.89
Females	0.90–1.21	1.05

The body sculpture in the specimens we saw shows only slight deviations from the species-typical pattern. In about half of the specimens, the rim of the hood is interrupted; this occurs mostly in males. In a few specimens, the large lateral carapace spines were slightly bifid.

While our material came from many localities within the species range, no one sample was large enough to treat statistically for comparative purposes. Thus little can be said about geographic variation, but when the Oregon specimens are lumped together, they are significantly smaller than the more northerly material from Washington. One sample of eight males from south of Gold Beach, Oregon, consisted of small-bodied animals with more numerous false articulations in the leg tibiae than larger specimens from farther north.

JUVENILE STAGES: Three subadults were seen. Their cuticles were finely granulated, with dispersed, rounded tubercles. The median process of the eye tubercle inserts more or less anteriorly and slopes obliquely upward, rather than being depressed nearly to the horizontal as in the adults. The palpi (figs. 178, 179) are strikingly different from those of the adults. The cuticle of the trochanters, femora, and patellae have fine, scalelike granulations, with some widely separated larger tubercles; the femora and patellae have more numerous clavate hairs, and these are present also on the tarsi, from which they are absent in adults.

RELATIONSHIPS: Clearly *D. mirabile* is closest to our new species from the Pacific North-



FIGS. 180–187. *Dendrolasma mirabile.* 180. Microsculpture of second leg femur, adult. 181. Same, subadult. 182. Seminal receptacles. 183. Penis, Mt. Rainier. 184–186. Penis tips, Mt. Rainier. 184. Ventral. 185. Lateral. 186. Dorsal. 187. Ovipositor, ventral. Scale line = 0.15 mm. for figures 180, 181; 0.085 mm. for figure 182; 0.2 mm. for figures 183, 187; 0.75 mm. for figures 184–186.

west, *D. dentipalpe,* differing from it in having a less differentiated suite of male secondary sexual characteristics. *Dendrolasma parvulum,* the Japanese species, is more

distant from the two American species, continuing the evolutionary trends already mentioned in the discussion of the subfamily.

DISTRIBUTION: The species is found in a long strip along the Pacific Coast of North America, from the southern border of Oregon to the southern border of Alaska, in the Coast Ranges and Cascade Mountains. Like *Orthol asma pictipes, D. mirabile* is a typical member of Van Dyke's (1919) Vancouveran fauna, though *O. pictipes* is more maritime in its distribution. By comparison with the ranges of some triaenonychid opilionids (Briggs, 1971) it is possible that there are enclaves of this species (or a close relative) in the scattered moist coniferous forests of Idaho.

RECORDS: *CANADA:* BRITISH COLUMBIA: Vancouver (no further data), ♀ (BCPM). Metlahcatlah (Metlakatla on modern maps; no further data except "Nathan Banks Coll." and "Keen"), juv. (MCZ). *UNITED STATES:* WASHINGTON: *Kittitas Co.:* 16.4 mi. NW Hyak on Rt. 90, June 23, 1966 (V. Lee), ♀ (CAS); 8.6 mi. NW Easton on Rt. 90, June 18, 1966 (T. Briggs, V. Lee, K. Hom), 2♂♂, 5♀♀ (CAS). *Thurston Co.:* 11.6 mi. E Macleary, June 22, 1966 (T. Briggs, A. Jung), 3♂♂ (CAS); Olympia (no further data), ♂ (AMNH); June 10, 1944 (H. Exline), ♂ (BMM). *Pierce Co.:* Mt. Rainier (no further data), 2♂♂ (AMNH); Longmire, Aug. 22, 1927 (no collector's name), ♀ (AMNH); Elbe, Sept. 14, 1975 (R. Crawford), 2 juvs. (BMM). *Lewis Co.:* Mt. Rainier National Park, Ohanapecosh Campground, Aug. 8, 1967 (T. Briggs), ♀ (CAS); 1 mi. S Doty, Chehalis R., July 11, 1975 (R. Crawford), ♂ (BMM). *Skamania Co.:* 2.5 mi. N Swift Reservoir Dam, June 21, 1966 (T. Briggs), ♂, ♀ (CAS); 5.7 mi. NE Cougar, May 22, 1976 (R. Crawford), ♀ (BMM). *Grays Harbor Co.:* 7.0 and 7.4 mi. WNW Matlock, Oct. 17, 1976 (R. Crawford), 2♀♀, 2 juvs. (BMM); Quinalt, Sept. 5, 1936 (L. Lloyd), ♀ (BMM). *King Co.:* Ravenna Park, NE Seattle, Sept. 17, 1972 (R. Crawford), ♀ (BMM); 2.2 mi. NE Fife, Aug. 22, 1978 (R. Crawford), ♀ (BMM); 10.7 mi. NNE North Bend, Apr. 23, 1977 (R. Crawford), ♀ (BMM); 6.6 mi. S Sultan, Apr. 14, 1973 (R. Crawford), ♀ (BMM); Des Moines, May 26, 1973 (R. Crawford), ♀ (BMM); Seattle, Feb. 16, 1901 (T. Kincaid), ♂ (BMM). *Skagit Co.:* 0.1 mi. E Lyman, Sept. 28, 1975 (R. Crawford), ♀ (BMM). *Mason Co.:* Le Bar Guard Station, 6 mi. N Cushman Dam, Aug. 14, 1933 (H. Exline), ♀ (BMM). *San Juan Co.:* Orcas Island, July 13, 1936 (M, Hesseman), ♀ (BMM). *Pacific Co.:* Bay Center, Aug. 5, 1931 (T. Kincaid), ♀ (BMM). *Jefferson Co.:* Hoh River Rain Forest, 10 mi. from US 101 on Upper Hoh River, Feb. 23, 1968 (D. Thompson, S. Pederson), ♀ (WAS). OREGON: *Clackamas Co.:* Mt. Hood, elevation 4300 ft., June 15, 1936 (S. Bishop), ♀ (AMNH); McMinnville (no further data), 4♂♂ (MCZ); 1 mi. S Barton, Apr. 22, 1972 (E. Benedict), ♂, 2♀♀ (WAS); 30 and 33 mi. SE Estacada, May 26, 1972 (E. Benedict), ♂, ♀ (WAS); 39 mi. SE Estacada, no date (E. Benedict), ♂, ♀ (WAS). *Douglas Co.:* Susan Creek E Glide, July 23, 1963 (V. Roth), ♀ (AMNH); 1 mi. S, 2 mi. W Ash, Dec. 22, 1972 (E. M. Benedict), 2♀♀ (WAS); 3.2 mi. NE Scottsburg, Dec. 22, 1972 (E. Benedict), 2♀♀ (WAS). *Lane Co.:* 7 mi. S Cottage Grove, June 29, 1953 (V. Roth), ♂ (AMNH); 3 mi. up Salmon Creek from Oakridge, no date (T. Briggs), ♀ (CAS); 17 mi. NE McKenzie Bridge, Oct. 16, 1971 (E. Benedict), ♀ (WAS); 4.5 mi. NW Cheshire, Dec. 4, 1971 (E. Benedict), ♂ (WAS). *Lincoln Co.:* 0.5 mi. E Cape Perpetua, Aug. 7, 1967 (K. Hom), ♀ (CAS). *Josephine Co.:* "near Wolf Creek (label partly illegible)," Aug. 6, 1967 (T. Briggs, K. Hom, S. Tom), 4♂♂, ♀, juv. (CAS). *Curry Co.:* 4.5 mi. S Gold Beach, June 19, 1966 (T. Briggs, V. Lee, A. Jung, K. Hom), 6♂♂, 3♀♀ (CAS); Boardman State Park, June 18, 1966 (A. Jung), ♀ (CAS); 5 mi. N Brookings, Feb. 12, 1972 (E. Benedict), ♀ (WAS). *Multnomah Co.:* 10 mi. N, 7 mi. E Sandy, Sept. 27, 1972 (E. Benedict), ♀ (WAS). *Yamhill Co.:* 5 mi. E Yamhill, Oct. 2, 1971 (E. Benedict), ♂ (WAS). *Coos Co.:* 14 mi. E, 2 mi. S Allegany, Nov. 21, 1971 (E. Benedict), juv. (WAS). *Benton Co.:* 0.5 mi. NW Glenbrook, Dec. 4, 1971 (E. Benedict), juv. (WAS). *Tillamook Co.:* Cape Lookout State Park, Apr. 9, 1967 (E. Benedict), 2♂♂, 2♀♀ (WAS). *Washington Co.:* 2 mi. N Helvetia, Jan. 21, 1968 (D. Malcolm), ♂ (WAS); Tualatin, Jan. 1, 1972 (E. Benedict), ♂, ♀ (WAS).

ECOLOGY: *Dendrolasma mirabile* is typical of moist coniferous forests of Douglas Fir and cedars, and of the Sitka Spruce forest of higher elevations. One specimen from Mt. Hood came from an elevation of about 1400 m.

Dendrolasma dentipalpe, new species
Figures 188–201; Map 2

TYPES: Male holotype from Carlotta, Humboldt Co., California, collected September 27, 1963 by W. J. Gertsch, deposited in AMNH. In addition, the material listed under "distribution" below has been designated paratypical and deposited in the given museums (AMNH, CAS).

DIAGNOSIS: Differing from *D. mirabile* and *D. parvulum* in the intricate, small-celled keel lattice, shorter legs, exaggerated cheliceral modifications of the males, medioapical tooth of the male palpal patella, and the very long penis with an elongated glans.

DESCRIPTION: Male holotype: Body more or less dark brown, with irregular lighter mottling; eye rings black. Scute with median row of intersegmental lighter spots, darker transverse zones between spine pairs, darker laterally; scute keels nearly black, hood and elongated marginal spines, coxae and trochanters pale. Leg femora dark, paler at base and apex, patellae dark, tibiae apically pale, metatarsi and tarsi dark brown. Dorsum without transverse furrows setting off metapeltidium, dense lattice of keels obscures scute segmentation, scute thus appearing as one solid unitary piece. Body strongly flattened, eye tubercle depressed, passing rostrally without obvious alteration into nearly horizontal median hood process. Hood (figs. 188–191) similar to that of *D. mirabile*; lateral carapace spines blunt, subcylindrical. Eye tubercle with five to seven small teeth in median row, small circumocular keel forms collar around eyes posteriorly. Front wall of carapace under hood with single (lower) transverse keel. Supracheliceral laminae as usual. Pleural sclerites inconspicuous. Dorsal scute densely "overgrown" with intricate network of small keel cells, only transverse keel on thorax 1 clearly differentiated; posterior border with fencelike transverse keel containing eight to 10 blunt spines. Free tergites 6 and 7 with low keels and dispersed tubercles in transverse rows; tergite 8 with lateral keel rudiment; corona analis tuberculate. Free sternites with transverse rows of tubercles, laterally becoming low keels. Genital operculum tongue-shaped, surface with small teeth. Coxal surfaces similar.

Chelicerae as in figures 192, 193. Basal article with large, hornlike apophysis slightly recurved, set with few setae and medially with a few low tubercles, no obvious glandular tissue, but a few small pores on apical part. Second article with large conical apophysis somewhat curved, with few setae below. Palpi as in figures 194–196. Trochanters oval, somewhat swollen dorsally; femora club-shaped, apical two-thirds thickened, bent ventrally, set with short, normal setae, no clavate hairs; patellae short, cylindrical, with a small apicomedial apophysis, no clavate hairs. Tibiae thick, cylindrical, very slightly curved ventrally, with basal stalk, clavate hairs on apical half of dorsal surface only. Tarsi oval, stalked, with small group of clavate hairs on dorsobasal surface.

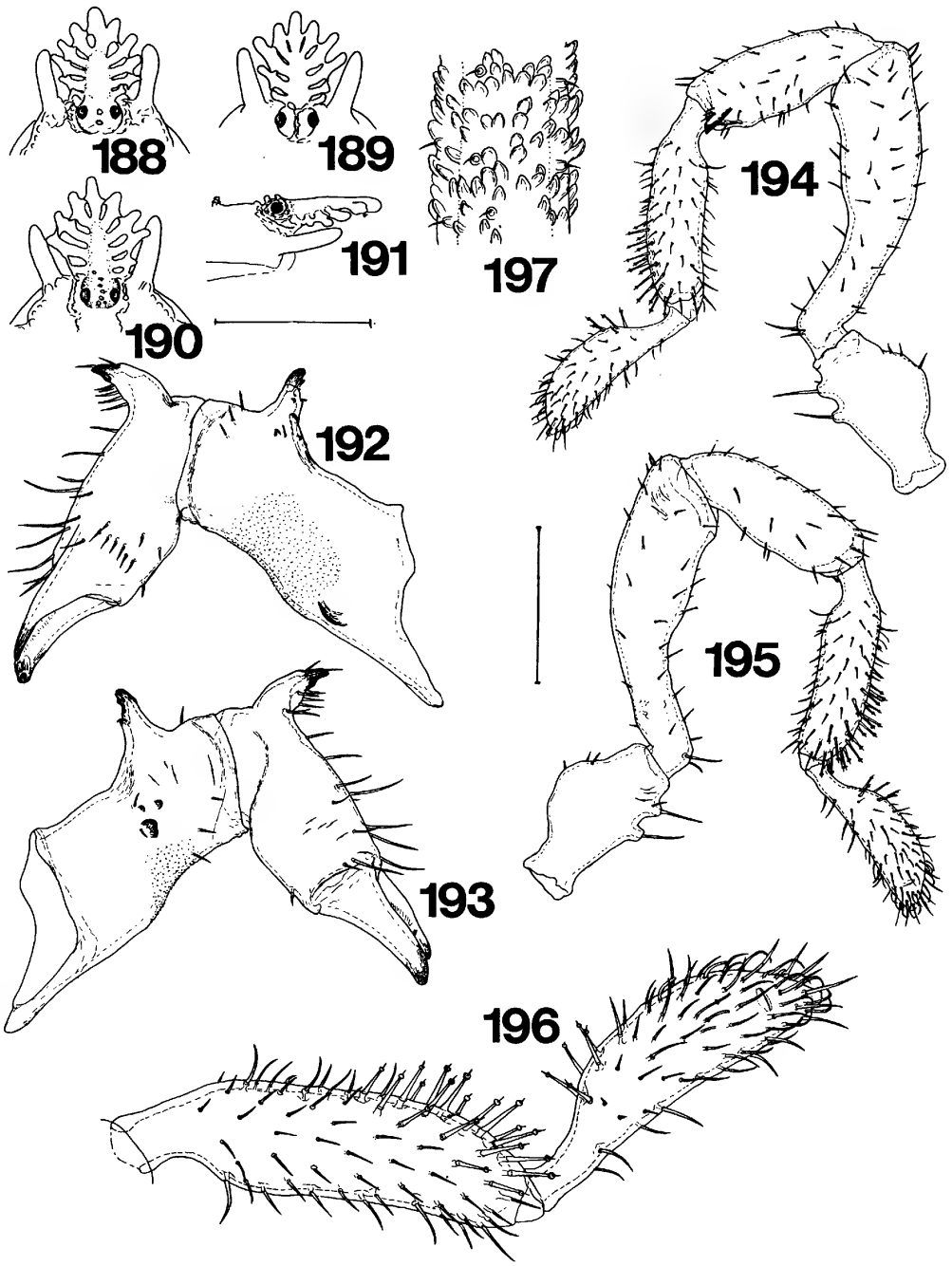
Leg femora strong, thickened, clublike, especially 1 and 3, 4 less so, 2 markedly more slender. Distinctive microsculpture as in figure 197, with broad, thick, conical, slightly curved denticles. Second tibiae and second and fourth metatarsi with pseudoarticulations. Metatarsi and tarsi with sculpture of typical microtrichia.

GENITAL MORPHOLOGY: Penis (figs. 198–201) very long, about two-thirds body length. Shaft slender, dark, cuticle finely wrinkled transversely. Glans long, tapering distally into very long stylus, with three pairs of large hooked and thickened curved spines on the basal part, three pairs of smaller, more slender, spindle-shaped setae on distal part. Style ventrally sclerotized, dorsally membranous, with helical torsion.

MEASUREMENTS: The major dimensions of the three known mature specimens are given in table 25. The lengths of the appendages of the holotype are given in table 26.

TABLE 25
Three Known Mature Male Specimens of *Dendrolasma dentipalpe*
(Measurements in millimeters.)

	Holotype	Paratype (Happy Camp)	Paratype (Crescent City)
Total length	3.2	3.2	3.1
Length less hood	2.6	2.6	2.5
Breadth of abdomen	1.8	1.8	1.8
Penis length	2.17	—	—
Length of femur 2	2.0	2.1	2.0



FIGS. 188–197. *Dendrolasma dentipalpe.* 188–191. Hoods of males. 188. Happy Camp, dorsal. 189. Crescent City, dorsal. 190. Holotype from Carlotta, dorsal. 191. Same, lateral. 192, 193. Male right chelicera. 192. Mesal view. 193. Lateral view. 194–196. Male right pedipalp. 194. Mesal view. 195. Lateral view. 196. Tibia and tarsus, enlarged lateral view. Note clavate hairs on dorsal side of tarsus near base. 197. Microsculpture of second leg femur, near middle. Scale lines = 1.0 mm. for figures 188–191; 0.35 mm. for figures 192, 193; 0.25 mm. for figures 194, 195; 0.13 mm. for figure 196; 0.2 mm. for figure 197.

TABLE 26
Leg and Palpal Segments of Male Holotype of *Dendrolasma dentipalpe*
(Measurements in millimeters.)

Segment	Legs				Palpus
	1	2	3	4	
Trochanter	—	—	—	—	0.27
Femur	0.9	2.0	1.0	1.4	0.55
Patella	0.3	0.6	0.3	0.5	0.34
Tibia	0.6	1.7	0.8	1.4	0.36
Metatarsus	0.5	1.8	0.6	0.9	—
Tarsus	0.4	1.1	0.5	0.6	0.29

The false articulations and tarsal numbers of the three specimens are as in table 27. For the leg segments other than tarsi, the numbers indicate false articulations, and for the tarsi, segment numbers.

VARIATION: Because only a few specimens are available, we prefer not to remark on any possible variations in this species, other than to present the information contained in the tables and in the illustrations.

JUVENILE STAGES: We have seen one subadult and one presubadult specimen. Generally the remarks made on this subject under *D. mirabile* are applicable.

RELATIONSHIPS: Clearly this is a more specialized form than *D. mirabile,* and the trends found in that species have even stronger expression here. Specializations unique to *D. dentipalpe* are the exaggerated cheliceral armature, the finely reticulated scute pattern, and the patellar tooth of the palpus. *Dendrolasma parvulum* of Japan appears less specialized, with a more oblique hood, shorter penis, and less differentiation of the chelicerae and palp.

TABLE 27
Tarsomere Numbers and Numbers of False Articulations in Pretarsal Leg Segments of Three Male Specimens of *Dendrolasma dentipalpe*[a]

	Holotype	Paratype (Happy Camp)	Paratype (Crescent City)
Femur 2	2–3/4	5/6?	3/3
Femur 4	1/1	2/1	0/0
Tibia 2	4/2	1/2	1/1
Metatarsus 2	3/2	2/2	1/1
Metatarsus 4	1/1	1/2	1/0
Tarsi 1	4(2+2)	4	4
Tarsi 2	7(5+2)	7/8(6+2)	8/9(7+2)
Tarsi 3	6(2+2+2)	6	6
Tarsi 4	6	6	6

[a] For the tarsi, numbers indicate tarsomeres; for the other leg segments, false articulations.

DISTRIBUTION: We have seen material from four localities in northwestern California; all are in the "Humboldtian district of the Pacific Maritime Biotic Province" (Schick, 1965).

RECORDS: CALIFORNIA: *Siskiyou Co.:* 18 mi. N Happy Camp, Aug. 22, 1959 (V. Roth, W. J. Gertsch), ♂ (AMNH). *Del Norte Co.:* 15.8 mi. N Humboldt–Del Norte County line on US 101, Jan. 30, 1967 (V. Lee), juv. (CAS); 0.5 mi. S Crescent City, Aug. 8, 1958 (L. M. Smith), ♂, juv. (AMNH).

ECOLOGY: Collectors' notes associate this species with stands of redwood.

ETYMOLOGY: The specific epithet refers to the teeth on the palpal patellae of the males of this species.

Dendrolasma parvulum (Suzuki)
Figures 202–210

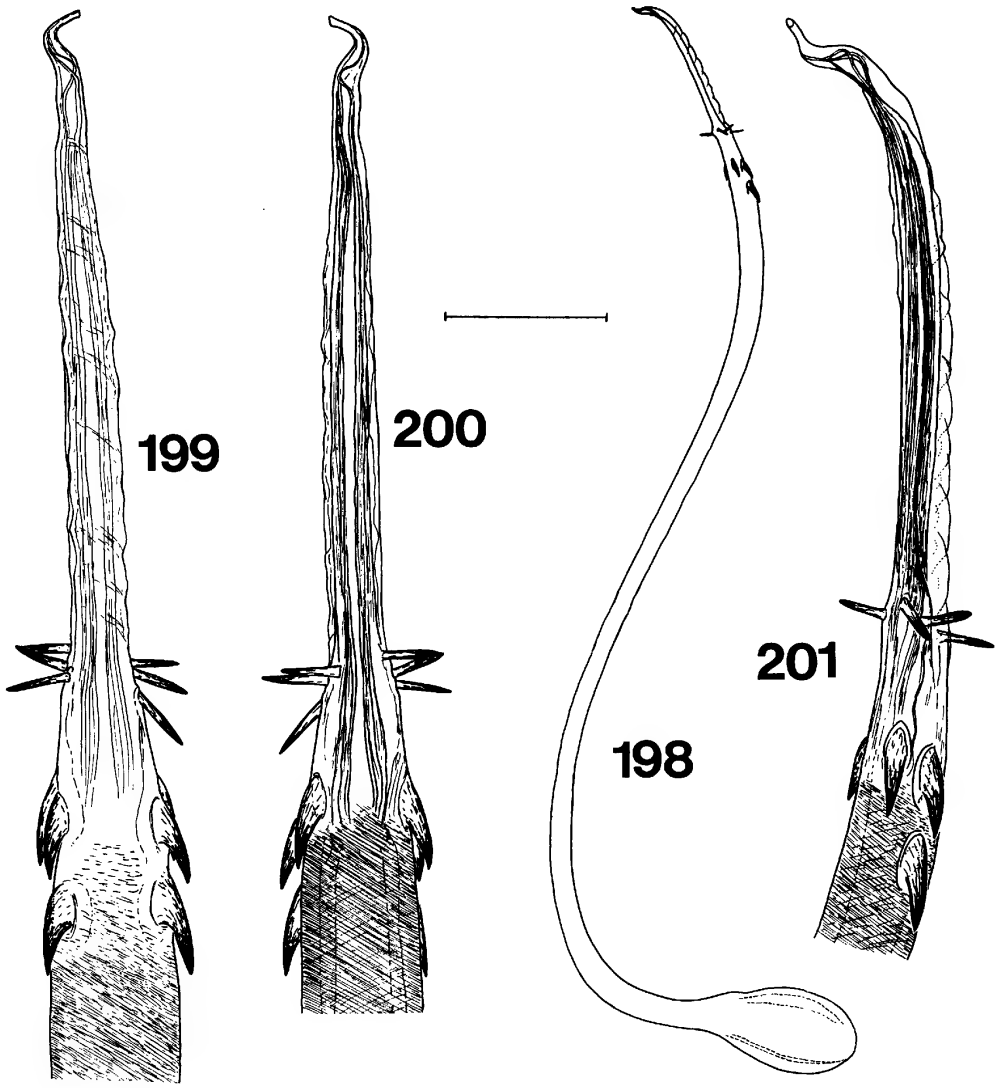
Cladolasma parvula Suzuki, 1963, p. 40, figs. 1–4; 1967, p. 5. Suzuki and Kunita, 1972, pp. 89, 92–93, figs. 2A, 3.

Dendrolasma parvula, Suzuki, 1974, p. 122, figs. 1–3; 1975, p. 86. Suzuki et al., 1977, pp. 121–123, 127–128, 135, fig. 1B.

TYPES: Juvenile male holotype from Mt. Ichizuchi-yama, Shikoku, Japan, in collection of Zoological Laboratory of Hiroshima University, Hiroshima, Japan, not examined.

DIAGNOSIS: Besides occurring far outside the range of other *Dendrolasma* species, *D. parvulum* differs from them in having only the small-celled keel network present in adults, and in the dimorphic penial spination showing a double row of six large spines on the dorsal side of the glans as well as several small spines clustered around the base of the stylus (figs. 205–210).

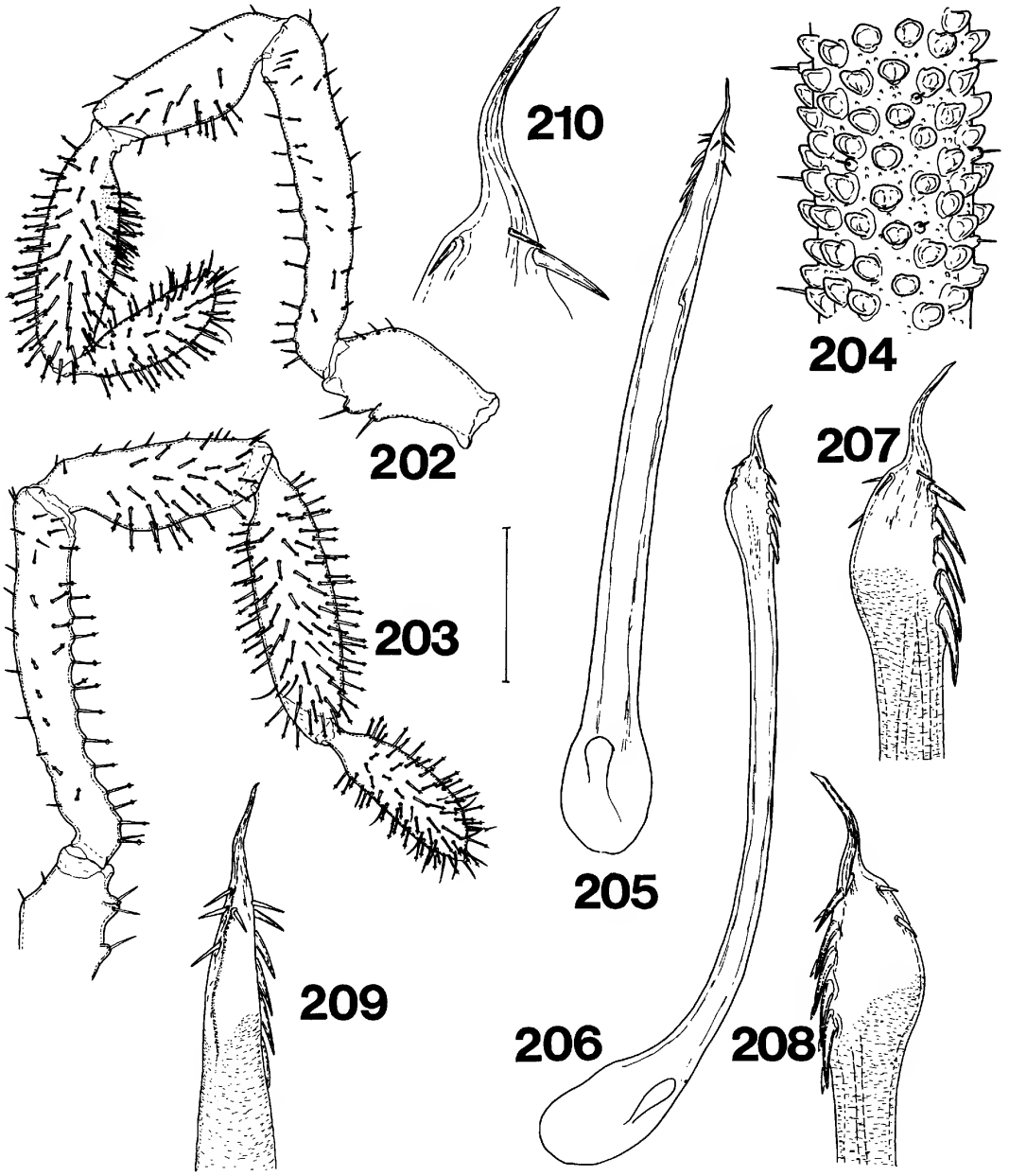
The complete redescription of this species from adults published by Suzuki in 1974 requires no elaboration on our part. Through the characteristic courtesy of Prof. Suzuki, we



FIGS. 198–201. *Dendrolasma dentipalpe*, penis. 198. Whole organ, lateral. 199–201. Penis tip. 199. Dorsal view. 200. Ventral view. 201. Lateral view. Scale line = 0.3 mm. for figure 198; 0.06 mm. for figures 199–201.

were able to examine adult male and female specimens and found his redescription to be accurate in every detail. However, for comparative purposes, we wish to draw attention to a few features of this animal. The palpus (figs. 202, 203) is more densely invested with clavate hairs than in other *Dendrolasma* species, and the metapeltidium is free. The peculiar dorsal ornamentation and the strongly dimorphic penial spination (figs. 205–210) are apomorphies which contrast with the foregoing primitive characteristics, and suggest to us that *D. parvulum* has had a history of long separation from its North American relatives.

DISTRIBUTION: The species is known from the mountains of Shikoku, Japan, where, according to Suzuki (1974), it is frequently found at the bases of sedge-tufts in a moist deciduous forest dominated by beech trees.



FIGS. 202–210. *Dendrolasma parvulum.* 202, 203. Pedipalps. 202. Male right palpus, mesal view. 203. Female left palpus, mesal view. 204. Microsculpture of second leg femur. 205–210. Penis. 205. Ventral view. 206. Lateral view. 207. Tip, lateral view of right side. 208. Same, left side. 209. Same, ventral view. 210. Lateral view, right side, enlarged. Scale line = 0.25 mm. for figures 202, 203; 0.15 mm. for figure 204; 0.3 mm. for figures 205, 206; 0.1 mm. for figures 207–209; 0.05 mm. for figure 210.

LITERATURE CITED

Axelrod, Daniel
1959. Geological history. *In* Munz, P. A., and D. D. Keck (eds.), A California flora. Berkeley, 1681 pp.

Bambach, Richard K., Christopher R. Scotese, and Alfred M. Ziegler
1980. Before Pangea: the geographies of the Paleozoic world. Amer. Sci., vol. 68, pp. 26–38, figs. 1–15.

Banks, Nathan
1894a. The Nemastomatidae and Trogulidae of the United States. Psyche, vol. 7, pp. 11–12.
1894b. Washington Phalangida, with a description of a new southern *Leiobunum*. Canadian Ent., vol. 26, pp. 160–164.
1901. Synopses of North American invertebrates. XVI. The Phalangida. Amer. Nat., vol. 35, pp. 669–679.
1904. Some arachnids from California. Proc. California Acad. Sci., vol. 3, pp. 329–376.
1911. The Phalangida of California. Pomona Jour. Ent., vol. 3, pp. 412–421.

Bragg, Paul D., and Robin Leech
1972. Additional records of spiders (Araneida) and harvestmen (Phalangida) for British Columbia. Jour. Ent. Soc. British Columbia, vol. 69, pp. 67–71.

Briggs, Thomas S.
1971. The harvestmen of the family Triaenonychidae in North America (Opiliones). Occas. Papers California Acad. Sci., no. 90, pp. 1–43, figs. 1–128, maps 1–5.

Cockerell, Theodore
1916. A new phalangid from the Coronados Islands. Ent. News, vol. 27, p. 158.

Comstock, John Henry
1913 (1912). The spider book. Garden City, 721 pp., 770 figs.
1940. The spider book, revised and edited by W. J. Gertsch. Ithaca, 730 pp., 771 figs.

Ferguson, W. E.
1962. Biological characteristics of the mutillid subgenus *Photopsis* Blake, and their systematic values (Hymenoptera). Univ. California Publ. Entomol., vol. 27, pp. 1–92, figs. 1–288.

Frey, D. G.
1965. Other invertebrates, an essay in biogeography. *In* Wright, H. E., Jr., and D. G. Frey (eds.), The Quaternary of the United States. Princeton, 922 pp.

Goldman, E. A., and R. T. Moore
1946. The biotic provinces of Mexico. Jour. Mammal., vol. 26, pp. 347–360, figs. 1–7.

Goodnight, Clarence J., and Marie Goodnight
1942. Phalangida from Mexico. Amer. Mus. Novitates, no. 1164, pp. 1–18, figs. 1–32.
1945a. Additional Phalangida from Mexico. *Ibid.*, no. 1281, pp. 1–17, figs. 1–22.
1945b. A representative of the Ischyropsalidae from Mexico. Trans. Connecticut Acad. Sci., vol. 36, pp. 249–252, figs. 1, 2.

Gruber, Jürgen
1976. Ergebnisse zoologischer Sammelreisen in der Türkei. Zwei neue Nemastomatidenarten mit Stridulationsorganen, nebst Anmerkungen zur systematischen Gliederung der Familien (Opiliones, Arachnida). Ann. Naturhistor. Mus. Wien, vol. 80, pp. 781–801, figs. 1–19.
1978. Redescription of *Ceratolasma tricantha* Goodnight and Goodnight, with notes on the family Ischyropsalidae (Opiliones, Palpatores). Jour. Arachnol., vol. 6, pp. 105–124, figs. 1–29.

Gruber, Jürgen, and Jochen Martens
1968. Morphologie, Systematik und Ökologie der Gattung *Nemastoma* C. L. Koch (*s. str.*) (Opiliones, Nemastomatidae). Senckenbergiana Biol., vol. 49, pp. 137–172, figs. 1–74.

Halffter, G.
1964. La entomofauna americana, ideas acerca de su origen y distribución. Folia Ent. Mexicano, vol. 6, pp. 1–108.

Heusser, C. J.
1965. A Pleistocene phytogeographical sketch of the Pacific Northwest and Alaska. *In* Wright, H. E., Jr., and D. G. Frey (eds.), The Quaternary of the United States. Princeton, 922 pp.

Hilton, William A.
1919. Phalangids from the Claremont-Laguna region. Jour. Ent. Zool. Pomona College, vol. 11, p. 41.

Hopkins, D. M.
1967. The Bering land bridge. Palo Alto, 273 pp.

Knapp, R.
1965. Die Vegetation von Nord- und Mittelamerika und der Hawaii-Inseln. Stuttgart, 373 pp.

Kratochvíl, Josef
1958. Die Höhlenweberknechte Bulgariens

(Palpatores—Nemastomatidae). Pr. Brn. Zakl. Čsl. Akad. Věd., vol. 30, pp. 523–576, figs. 1–47.

Linsley, E. Gordon
1958. Geographical origin and phylogenetic affinities of the cerambycid beetle fauna of western North America. Amer. Assoc. Adv. Sci. Publ., no. 51, pp. 299–320.

Ljovushkin, S. I.
1971. Biospeleologica Sovietica XLIII. Report on the first finding of the American genus *Taracus* Simon, 1879 (Opiliones, Ischyropsalididae) in Asia, with a description of *T. birsteini,* n. sp., from a cave in the southern part of the Primorsky Krai. Bull. Moscow Soc. Natur., Biol. Ser., vol. 76, pp. 127–133, figs. 1–3.

Martens, Jochen
1969. Die Abgrenzung von Biospezies auf biologisch-ethologischer und morphologischer Grundlage am Beispiel der Gattung *Ischyropsalis* C.L. Koch 1839 (Opiliones, Ischyropsalididae). Zool. Jahrb. Syst., vol. 96, pp. 133–264, figs. 1–68.
1972. Opiliones aus dem Nepal-Himalaya. I. Das Genus *Sabacon* Simon (Arachnida: Ischyropsalididae). Senckenbergiana Biol., vol. 53, pp. 307–323, figs. 1–54.
1976. Genitalmorphologie, System und Phylogenie der Weberknechte (Arachnida, Opiliones). Ent. Germanica, vol. 3, pp. 51–68, figs. 1–46.
1978. Weberknechte, Opiliones. Tierwelt Deutschlands, vol. 64, pp. 1–464, figs. 1–815.

Martens, Jochen, Ulrich Hoheisel, and Marianne Götze
1981. Vergleichende Anatomie der Legeröhren der Opiliones als Beitrag zur Phylogenie der Ordnung (Arachnida). Zool. Jb. Anat., vol. 105, pp. 13–76, figs. 1–44.

Martens, Jochen, and Seisho Suzuki
1966. Zur systematischen Stellung ostasiatischer Ischyropsalididen-Arten (Arachnoidea, Opiliones, Ischyropsalididae). Annot. Zool. Japon., vol. 39, pp. 215–221, figs. 1–16.

Martin, P. S., and P. J. Mehringer, Jr.
1965. Pleistocene pollen analysis and biogeography of the Southwest. *In* Wright, H. E., Jr., and D. G. Frey (eds.), The Quaternary of the United States. Princeton, 922 pp.

Munz, P. A., and D. D. Keck
1959. A California flora. Berkeley, 1681 pp.

Roewer, Carl-Friedrich
1923. Die Weberknechte der Erde. Jena, 1116 pp.
1940. Neue Assamiidae und Trogulidae. Weitere Weberknechte X (10. Ergänzung der "Weberknechte der Erde," 1923.). Veröff. dt. Kolonial.-u. Übersee-Mus., vol. 3, pp. 1–31, figs. 1–30.
1950. Über Ischyropsalidae und Trogulidae. Weitere Weber-Knechte XV. Senckenbergiana, vol. 31, pp. 11–56, figs. 1–66.

Rowland, J. Mark
1972. Origins and distribution of two species groups of Schizomida (Arachnida). Southwestern Nat., vol. 17, pp. 153–160, figs. 1, 2.

Ryckman, R. E.
1962. Biosystematics and hosts of the *Triatoma protracta* complex in North America (Hemiptera: Reduviidae) (Rodentia: Cricetidae). Univ. California Publ. Ent., vol. 27, pp. 93–240, figs. 1–416.

Savage, Jay M.
1960. Evolution of a peninsular herpetofauna. Syst. Zool., vol. 9, pp. 184–212.

Schenkel, E.
1951. Spinnentiere aus dem westlichen Nordamerika, gesammelt von Dr. Hans Schenkel-Rudin. Zweiter Teil. Verh. Naturf. Ges. Basel, vol. 62, pp. 24–62, figs. 1–51.

Schick, Robert X.
1965. The crab-spiders of California (Araneae, Thomisidae). Bull. Amer. Mus. Nat. Hist., vol. 129, pp. 1–180, figs. 1–262, maps 1–40.

Shear, William A.
1975a. The opilionid family Caddidae in North America, with notes on species from other regions (Opiliones, Palpatores, Caddoidea). Jour. Arachnol., vol. 2, pp. 65–88, figs. 1–32.
1975b. The opilionid genera *Sabacon* and *Tomicomerus* in America (Opiliones, Troguloidea, Ischyropsalidae). *Ibid.,* vol. 3, pp. 5–29, figs. 1–37.
1977. *Fumontana deprehendor,* n. gen., n. sp., the first triaenonychid opilionid from eastern North America (Opiliones: Laniatores: Triaenonychidae). *Ibid.,* vol. 3, pp. 177–183, figs. 1–16.
1980. A review of the Cyphophthalmi of the United States and Mexico, with a proposed reclassification of the suborder (Arachnida, Opiliones). Amer. Mus. Novitates, no. 2705, pp. 1–34, figs. 1–33.

Shelford, Victor E.
1963. The ecology of North America. Urbana, 610 pp.

Šilhavý, Vladimír
1967. *Anarthrotarsus martensi,* ein neuer Weberknecht aus Griechenland (Arach., Opiliones). Senckenbergiana Biol., vol. 48, pp. 175–178, figs. 1–4.
1973. Cavernicolous opilionids from Mexico (Arachnida: Opiliones). Accad. Naz. Lincei, Prob. Att. Cult. Sci., quad. 171, pp. 175–194, figs. 1–49.

Suzuki, Seisho
1963. *Cladolasma parvula,* gen. et sp. nov. (Trogulidae: Opiliones) from Japan. Annot. Zool. Japon., vol. 36, pp. 40–44, figs. 1–4.
1967. The Zoogeographical relationships of the Japanese Opiliones. Japan Soc. Syst. Zool., Circular 36, pp. 4–8, 2 maps.
1972. On the discontinuous distribution in some Opiliones. Acta Arachnol., vol. 24, pp. 1–8, figs. 1–4.
1974. Redescription of *Dendrolasma parvula* (Suzuki) from Japan (Arachnida, Opiliones, Dyspnoi). Jour. Sci. Hiroshima Univ., Ser. B, Div. 1 (Zool.), vol. 25, pp. 121–128, figs. 1–18.
1975. The Japanese species of the genus *Sabacon* (Arachnida, Opiliones, Ischyropsalididae). *Ibid.,* vol. 25, pp. 83–108, figs. 1–13.
1976. Two triaenonychid harvestmen from the Northeast, Japan (Triaenonychidae, Opiliones, Arachnida). *Ibid.,* vol. 26, pp. 177–185, figs. 1–25.

Suzuki, Seisho, and T. Kunita
1972. Opiliones of Ehime Prefecture, Japan, Shikoku. Ehime-no-Seibutsu, vol. 8, pp. 89–94, figs. 1–6. (In Japanese.)

Suzuki, Seisho, K. Tomijima, S. Yano, and T. Tsurusaki
1977. Discontinuous distribution in relict harvestmen (Opiliones, Arachnida). Acta Arachnol., vol. 27, pp. 121–138, figs. 1–7. (In Japanese.)

Thorne, R. F.
1969. The Californian islands. Ann. Missouri Bot. Gar., vol. 56, pp. 391–408.

Van Dyke, E. C.
1919. The distribution of insects in western North America. Ann. Ent. Soc. Amer., vol. 12, pp. 1–12.

Wachmann, Ekkehard
1970. Der Feinbau der sogenannten Kugelhaare der Fadenkanker (Opiliones, Nemastomatidae). Z. Zellforsch., vol. 103, pp. 518–525, figs. 1–6.

Wahrhaftig, C., and J. H. Birman
1965. The Quaternary of the Pacific Mountain system in California. *In* Wright, H. E., Jr., and D. G. Frey (eds.), The Quaternary of the United States. Princeton, 922 pp.

Whittaker, R. H.
1961. Vegetation history of the Pacific Coast States and the "central" significance of the Klamath Region. Madroño, vol. 16, pp. 5–23.

Wolfe, J. A., and E. B. Leopold
1967. Neogene and early Quaternary vegetation of northwestern North America and northeastern Asia. *In* The Bering Land Bridge, Princeton, pp. 193–206 (see D. M. Hopkins, *op. cit.*).

Zweifel, R. G.
1955. Ecology, distribution and systematics of frogs of the *Rana boylei* group. Univ. California Publ. Zool., vol. 54, pp. 207–292.